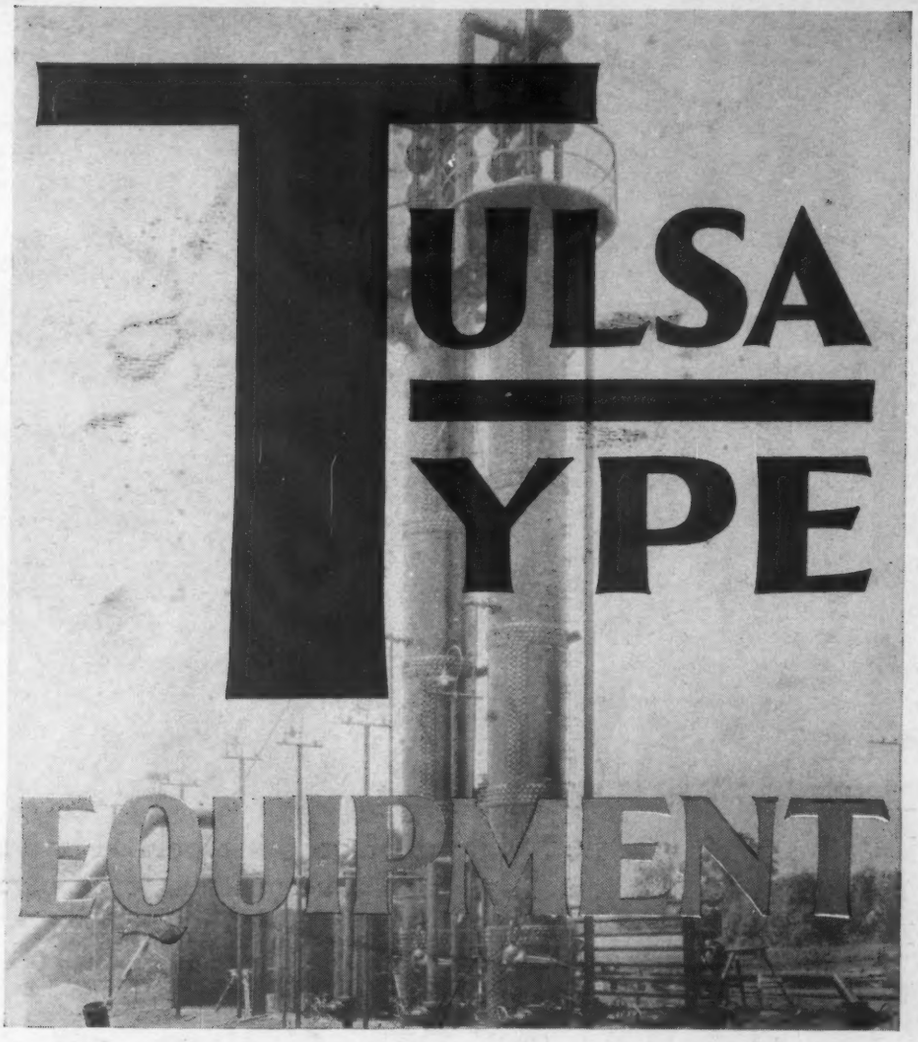
The REFINER AND NATURAL GASOLINE MANUFACTURER

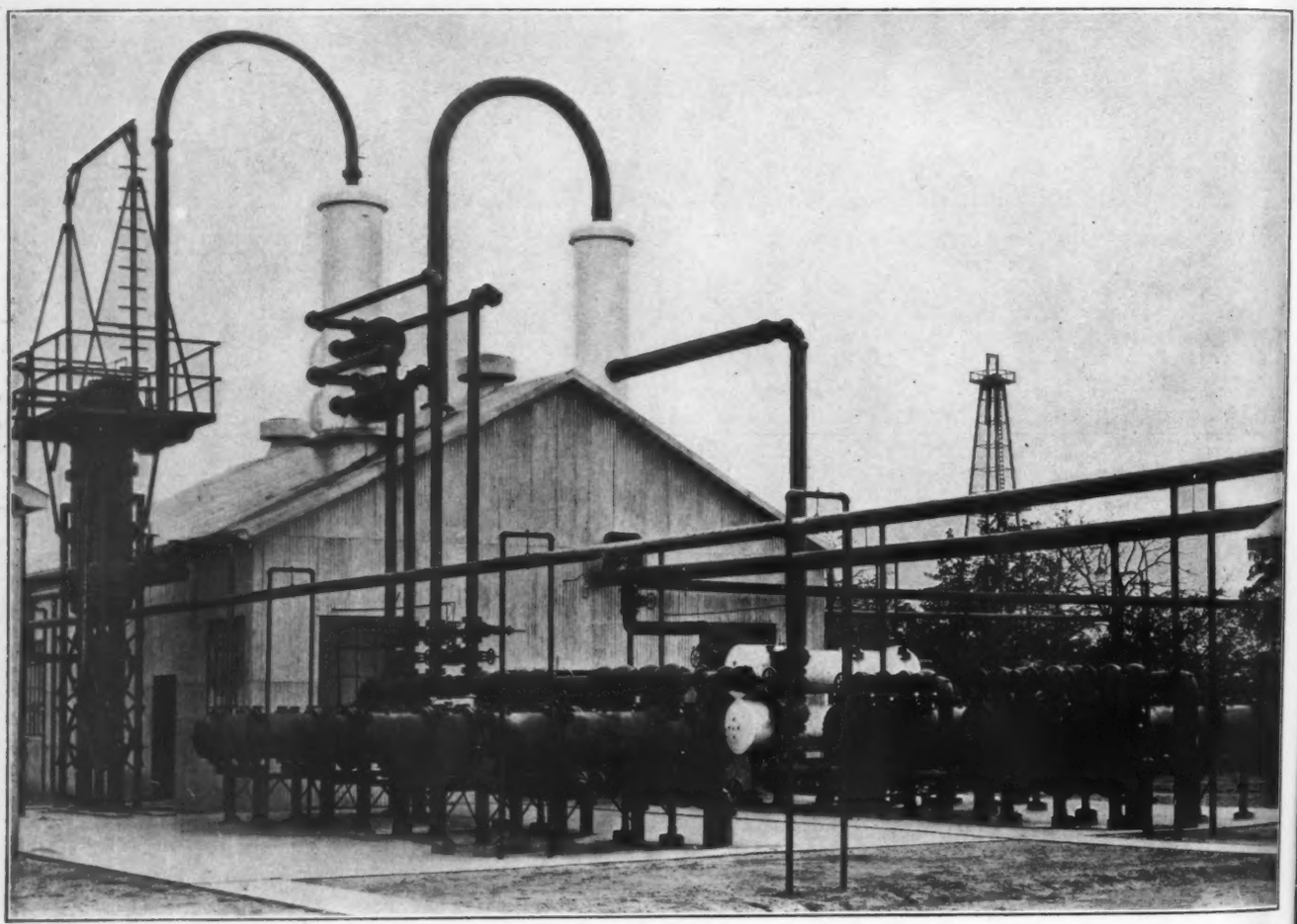


TULSA

Boiler & Machinery Co.

TULSA OKLAHOMA

BRAUN
ABSORPTION PLANTS



Braun equipped absorption plant.

Rated capacity 15,000 gallons of gasoline per 24-hours. This plant has made as high as 50,000 gallons of gasoline per 24 hours.

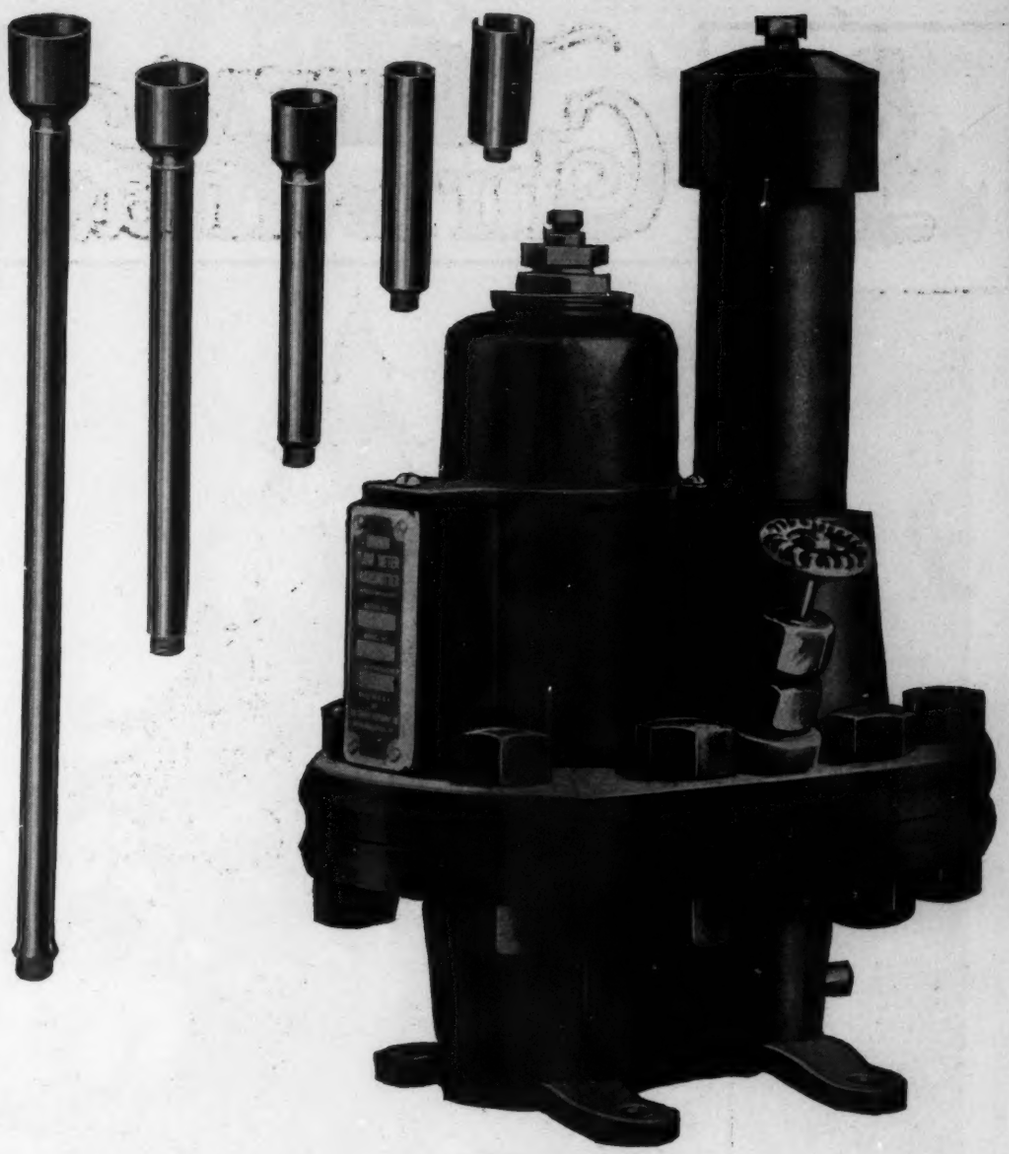
C·F·BRAUN & CO.

Manufacturing Mechanical Engineers

ALHAMBRA, CALIFORNIA

TULSA Kennedy Bldg.
DALLAS Republic Bank Bldg.
HOUSTON Neils Esperson Bldg.
CHICAGO Engineering Bldg.
NEW YORK 120 Broadway

Entered as second class matter June 16th, 1923, at the Postoffice at Houston, Texas, under the act of March 3, 1879.



6 Different Ranges

Simply changing the standpipe here changes the Flow Meter range.

That is, if you use Brown Electric Flow Meters.

Moreover, it is very inexpensive to make this change.

And the operation is very simple.

This is just one of the big flow meter advantages obtainable only by the use of Brown Electric Flow Meters.

Get full details in Catalog No. 20. The Brown Instrument Company, 4460 Wayne Avenue, Philadelphia.

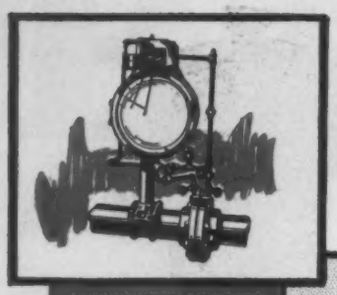
Branches in 20 principal cities.

"TO MEASURE IS TO ECONOMIZE"—PASCAL

Brown Electric Flow Meter

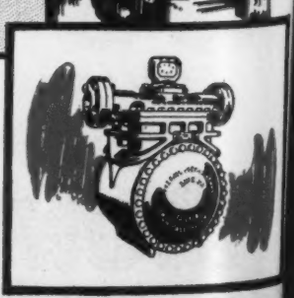
on the Inductance Bridge Principle

Mention Where You Saw the Advertisement



Merry Christmas

and full measure of happiness for 1929



Mention Where You Saw the Advertisement

Vol. 7, No. 12 DECEMBER, 1928

The REFINER

AND NATURAL GASOLINE MANUFACTURER

Edited Monthly at Tulsa, Oklahoma

GRADY TRIPLETT, *Editor* GEORGE REID, *Associate Editor*

TABLE OF CONTENTS

BEGIN AT HOME 55
An Editorial by Grady Triplett

TOWERS IN SERIES FRACTIONATE COLD TEST LUBE DISTILLATE 57
By George Reid

REFINERY OPERATIONS REFLECT EFFORT TO CONTROL OUTPUT 60
By H. J. Struth

A GRAPHICAL ANALYSIS OF DISTILLATION PROBLEMS 63
By E. G. Ragatz

THE PRESENT AND POTENTIAL MARKET FOR OIL FUELS FOR HEATING 67
By Trell W. Yocum

EMPLOYES COMMITTEES MAKE SAFE MEN 75
By W. Graham Cole

REFINERIES MAKE NOTABLE PROGRESS IN ECONOMY IN FUEL CONSUMPTION 76

INSTITUTE INAUGURATES MOVE TO FORM REFINERY TECHNOLOGY SECTION 77

PROBLEMS IN THE DESULPHURIZATION OF PETROLEUM PRODUCTS 79
By E. A. Dunstan

APPLICATION OF THE PIPE STILL TO VACUUM DISTILLATION 85
By A. E. Harnesberger

REFINING OF GASOLINE DISTILLATES FROM WEST TEXAS CRUDES 88
By H. H. Hewetson

REDUCING 2500 BARRELS PER DAY PENNSYLVANIA CRUDE TO CYLINDER STOCK BOTTOMS ON SINGLE PIPE STILL 91
By A. C. Vobach

THE REFINING OF PECOS COUNTY, TEXAS, CRUDE OIL 102
By Sidney Born

THE RELATION OF THE LIQUEFIED PETROLEUM GAS INDUSTRY TO THE OIL INDUSTRY 105
By R. C. Alden

UTILIZATION OF HEAVY ACID SLUDGE 109
By Harold G. Osborn and Lloyd L. Davis

CALIFORNIA ASSOCIATION SETS PACE ON WEST COAST 114
By Brad Mills

REFINERY AND GASOLINE PLANT ACTIVITIES 122

ABSTRACTS OF TECHNICAL LITERATURE 133

NEW EQUIPMENT 141

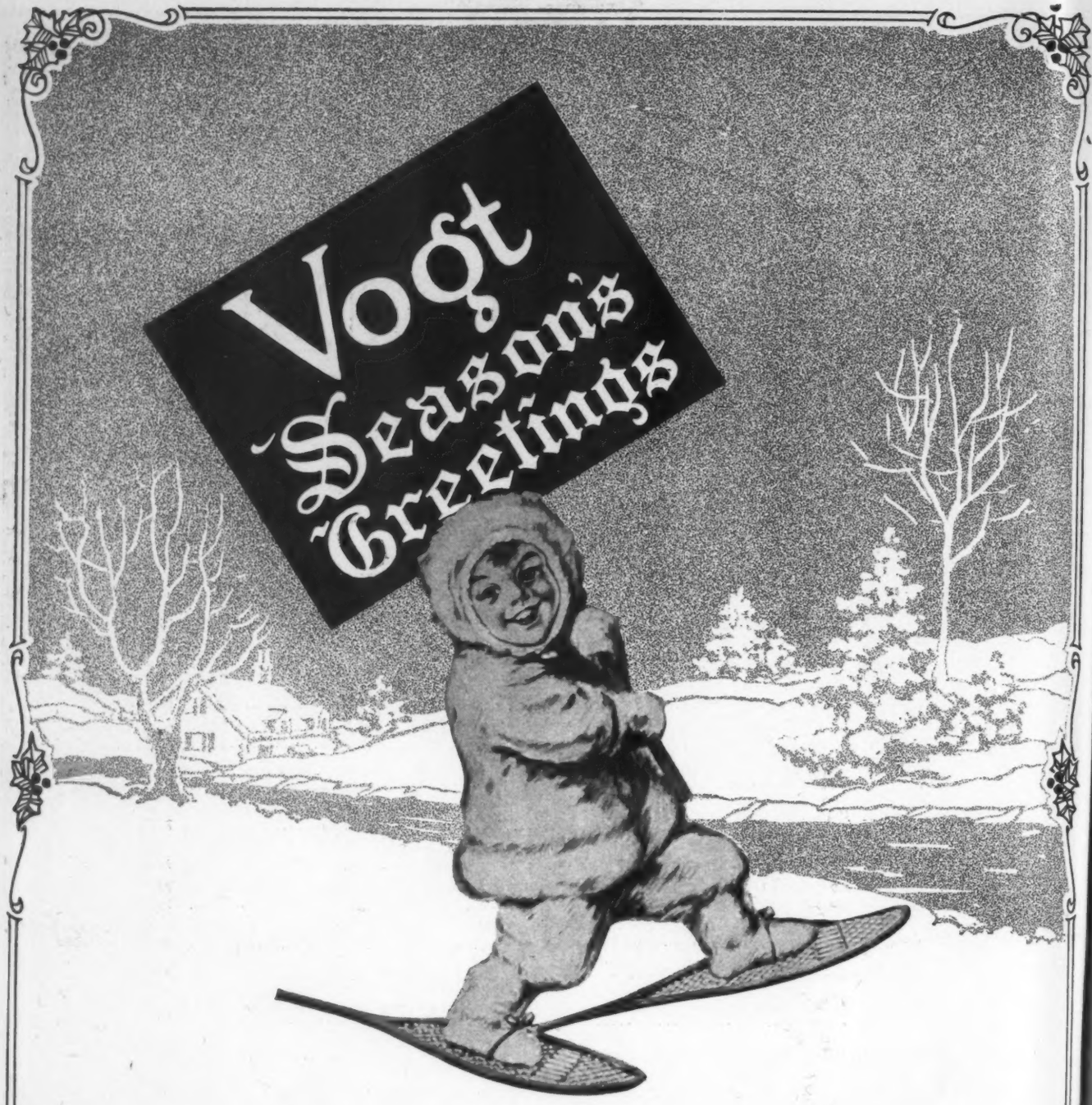
Published Monthly by GULF PUBLISHING COMPANY
Copyrighted, 1928

R. L. DUDLEY, *President* — A. L. BURNS, *General Manager* — SPENCER W. ROBINSON, *Editorial Director* — J. KENT RIDLEY, *Managing Editor*

Editorial Office: 913-916 Hunt Building, Tulsa, Oklahoma

Office of Publication: 3301 Buffalo Drive, Houston, Texas

NEW YORK: Room 408-409, 250 Park Avenue, R. P. Swinsky, Manager. PITTSBURGH: 510 Park Bldg., W. W. Pigue, Manager. CHICAGO: Room 520, 624 S. Michigan Ave., O. R. Waller, Manager. LOS ANGELES: 416-417 Haas Bldg., Wm. V. Gross, Manager. TULSA: 913-916 Hunt Bldg., J. F. Carter, Jr., Manager. FORT WORTH: 203 W. T. Waggoner Bld., H. H. King, Manager. Single copies 20 cents. Domestic subscription price, $1.00 a year. Foreign subscription price $1.50 a year. Advertising rates upon application.



The Spirit Of The Season Prompts
Us To Express To You Our Best
Wishes For A Merry Christmas
And A Happy, Prosperous New Year

Henry Voqt Machine Co.
Louisville, Kenturky.

Begin at Home

THERE is no fair way to cheat.

When the employes of a bank or a department store are invited to buy gasoline at two cents under the service station price, the effort is little short of dishonest.

Recently the whole petroleum industry has been striving to get away from some selling ills. The service station Q. D. A. was taken from the policies of some concerns and independent jobbers followed in creditable numbers.

Now come some of the larger independent concerns, those with their own refineries and retail outlets with subterfuge in an effort to bolster sales. Briefly, their plan is this: Some representative of the oil company goes to the manager of a department store. The manager shortly writes a general letter, which informs employes to buy gasoline from this oil company and receive a discount of two cents a gallon. It is classed as a commercial discount.

The Quantity Discount Agreement may not have been good business but it was honest. Its terms were generally known and fairly applied. The lone service station owner, selling at two cents under the prevailing market may also lack business judgment, still his ways can be approved.

But when a substantial oil company seeks to sell below prevailing prices by making its commercial discount apply to a hundred or more sales persons of a department store, the effort is lacking both in soundness and in honesty.

If the retail price of gasoline is too high, it should be reduced.

If the price is fair, it should apply to the bank teller as it does to the bricklayer. Counting money or measuring percale involve nothing to warrant cheaper motor fuel.

The company that seeks such patronage, breaks faith. From its best customer, the man who pays cash, it demands a premium in a fixed and highest price. From another type of customer, one connected with some large commercial concern, it sells at a discount. In the latter case sales are on credit, involving both accounting and possible loss of money.

If gasoline is to have two prices, fair dealing would seem to dictate that the lower price be to the man who pays cash for each filling of his tank.

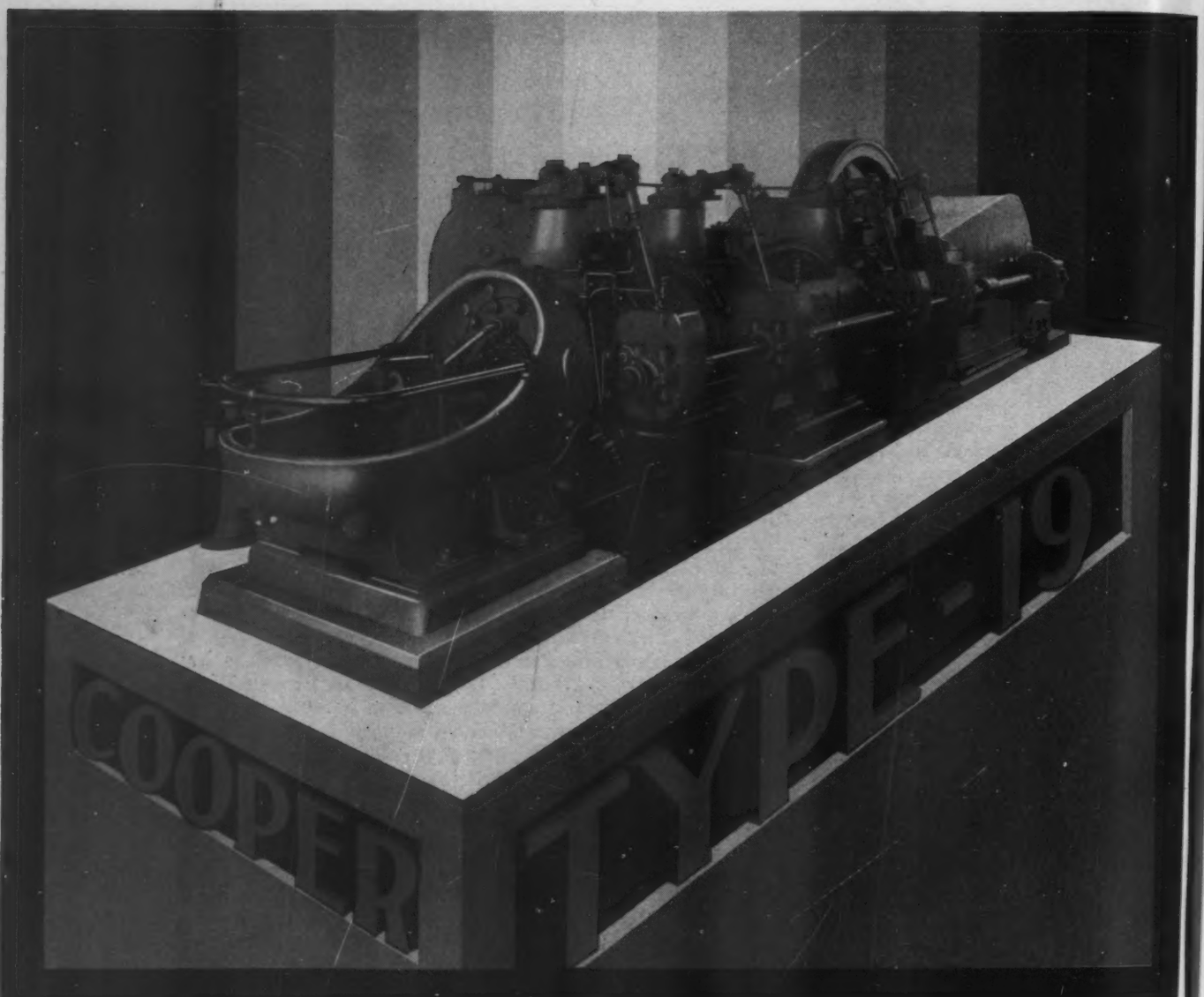
The cut price petroleum jobbers have been condemned in all manner of words. Executives of concerns which seek to evade sound selling, contribute to the existence of the cut price dealer. When doubtful commercial discounts become known, buyers who learn of it seek the merchant who sells below the market. The prices and policies of this merchant are known.

Of late there has been much discussion of a "code of marketing practice" for the petroleum industry. Codes are good in so far as they stimulate action. But the petroleum industry is not so much in need of codes as it is in need of men who will decline to place their scheme of commercial discount on a piece of India rubber, so it can be stretched to meet desirable patronage.

There is one certain method of correcting unfair and uneconomic marketing practices. Sound and honest selling will prevail when the men charged with selling decline to adopt unfair practices.

Sound business is not so much a question of what a whole industry is doing as it is of what one man or one concern is doing.

Grady Tribbett



An intermediate size gas engine—built for conditions where the utmost in continuous, reliable and economical operation is desired. They provide maximum power for minimum weight and exceptionally low installation and maintenance costs.

Rated 380-400 B. H. P. as single tandems and 760-800 B. H. P. as twin tandems for direct driving compressor cylinders or electric generators.

THE C. & G. COOPER COMPANY, MT. VERNON, OHIO

1111 Magnolia Bldg., Dallas, Texas 649 S. Olive St., Los Angeles, Calif. 615 Kennedy Bldg., Tulsa, Okla.

Towers in Series Fractionate Low Cold Test Lube Distillate

By GEORGE REID
Associate Editor

INCORPORATED in the construction and operation of the El Dorado, Arkansas, refinery of the McMillan Petroleum Products Company are some novel and interesting features. This plant processes about 1500 barrels daily of heavy Smackover crude, employing a preheater coil and pipe still with subsequent fractionation of the entire vaporized portion of the crude into naphtha, gas oil, lubricating oil distillates and asphalt flux through the us of three towers in series.

The heating equipment consists of one small preheater coil fired separately, which is composed of 25 four-inch tubes. The retort consists of 60 tubes, four inches in diameter; the tubes being equipped with removable plug-type return bends for ease of cleaning or repair.

Crude oil charged to the plant first passes through the heat exchangers which are made up of three eight-inch pipes 40 feet in length. Four 2-inch lines are placed inside of the eight-inch. Crude enters the exchanger flowing through the eight-inch outside pipe at a temperature of about 110 F. In passing through the first length of the exchanger the oil is raised to about 180 F. Between the first and second pass or sections the oil is conducted into a small dewatering tank erected above the horizontal exchangers as shown in the accompanying photograph. Practically all of the water and foreign matter settled out in this cylinder, from which it is periodically blown off. Crude at this stage is under a pressure of 75 to 100 pounds per square inch. From the dewatering drum the partially preheated crude flows through the remaining two sections of the exchanger and is increased in temperature to 240 F.

The heating material in the exchangers is, of course, the hot flux or residuum from the bottom of the first of the fractionating columns. This material arrives at the exchangers, flowing through the 2-inch inside tubes, at 650 F. In exchange of heat this flux is reduced to about 400 F. The dewatering tank is necessary, since the type of crude run contains from 1.0 to 2.5 per cent. water, averaging around 1.5 per cent. The settling tank at the exchangers is sufficiently efficient, or to the extent that no difficulty is encountered in the distillation equipment resulting from water "shots."

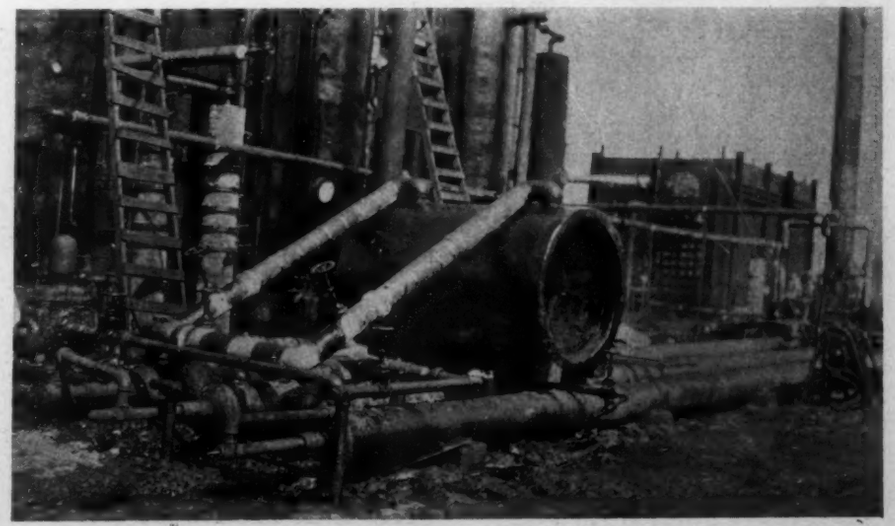
AUTOMATIC FLOW CONTROL

Leaving the exchangers the crude enters the preheater coil where the temperature is raised from 240 to 400 F. The oil then flows directly into the tube still, entering at a pressure of about 40 pounds. Still outlet pressure is approximately 25 to 30 pounds. The tube still is operated usually at about 690 F. which is sufficient to reduce the heavy Smackover crude of 19 to 22 degrees A. P. I. gravity to an asphalt flux having a flash point of 525 to 540 F, and to vaporize all of the nahptha, gas oil, and lube distillates.

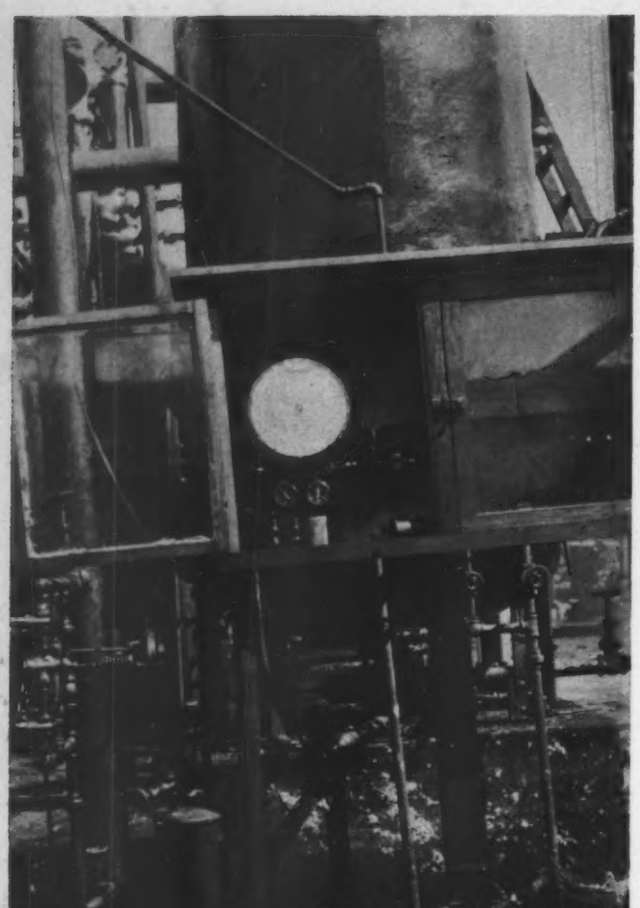
One of the interesting features of this plant is the installation and use of an automatic recording differential flow controller, Foxboro type, which is placed on the crude charging line to stills. The plant is replete with both recording and indicating control instruments but through the operation of the flow controller all of the remaining recording controllers are enabled to function more accurately and with less sudden or abrupt changes to affect them. The flow control device assures a uniform rate of flow of oil to the preheater and pipe still, and therefore it affects a desirable uniformity of vapors in the fractionating columns or a steady flow of oil to the towers. This uniform and constant flow of oil and vapors affects a "straightening out" of the curve made by the temperature recorder on the outlet of the retort, and also results in the securing of straight curves on the subsequent temperature charts all the way through the plant, resulting in accurate and uniform control of plant operations. With the plant operating at 1500 to 1600 barrels per day, the recording differential flow control instrument is governing flow of oil at the rate of 65 to 70 barrels hourly.

REMOVING ASPHALT FLUX

Hot oil from the retort is conducted to the first of



Heat Exchangers and dewatering tank. Exchangers made of eight-inch casing, 40 feet long, with two-inch inside coils-preheating from 110 to 240 F.



Automatic recorder controller controlling volume of recycle media sprayed over tower to govern tower operating temperature.

the three towers, which is called the stripper tower, at a temperature of 690 F. This tower is 20 feet by four feet in dimensions. The oil enters the tower three or four plates from the top and flows downward over a few more plates, to accumulate at the bottom and passing out into the heat exchangers. This residuum is six or seven gravity at 525 to 540 flash. It constitutes 50 to 52 per cent. of the oil charged to stills.

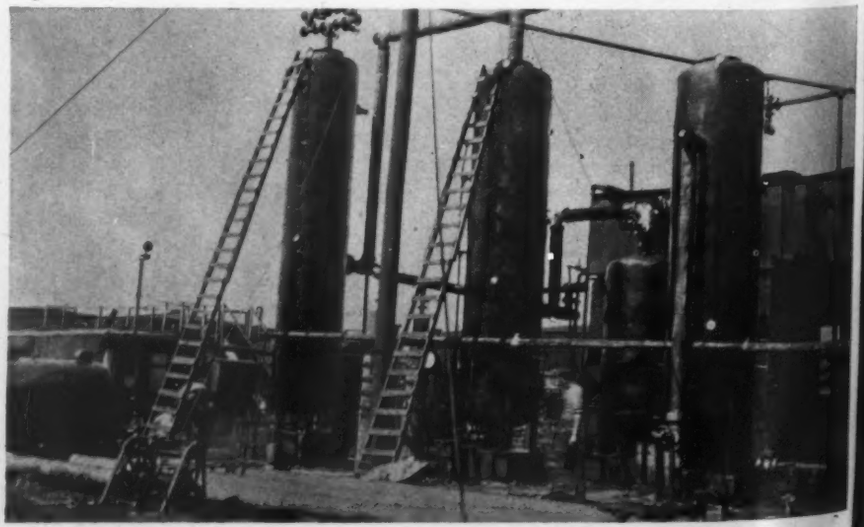
This influx or asphalt is conveyed from the exchangers to a nearby asphalt plant recently installed by James B. Berry & Sons, the only one of its sort manufacturing asphalt from Smackover crude. The asphalt plant consists essentially of a pan type retort equipped with an air coil in the bottom provided with numerous air outlets. The asphalt is charged, heated and blown with air, supplied by a Connersville blower, until the charge reaches the proper specifications of 140-160 penetration and about 110 F, melting point. The Smackover asphalt is utilized by the Berry company in the preparation of roofing material.

In the first tower at the McMillan plant the asphalt flux and the entire vaporized portion of the crude charged, which is about 50 per cent of the crude, is separated. The vapors leave the stripper tower and are passed through a small scrubber tower in which there is but one plate. This scrubber drum serves to knock out any entrainment carried over by the vapors from the stripper column. The scrubber is equipped with a gauge glass which indicates the liquid level in the bottom of the drum, and a Fisher liquid level regulator controls the flow of condensate away from the scrubber, maintaining a constant level.

FRACTIONATING EQUIPMENT

The fractionating columns at the McMillan plant are all Boner and Shelden type. The plates employed in securing fractionation in the towers are a circular steel plate with a rectangular section removed from the center. In this section there is inserted a screen made of Monel metal. Above the screen is placed a baffle plate of sheet steel which serves as a froth or foam breaker. The metal screen is enclosed in a rectangular box, one side of which is a weir box. The reflux tubes or overflow channels from each succeeding plate above drop into the weir box of the plate below, allowing the reflux to flow in a steady uniform stream, at a given height, and to overflow onto the screen below. The weir box maintains a uniform level of flux on the screens. The rectangular reflux tubes are staggered alternated up the height of the tower. Metal plates above the screens prevent any carry over from one plate to another, and aid in the securing of very intimate contact between liquid and vapors. The towers when operating at the capacity for which they were designed secure what is termed a "negative gap" between end point of overhead distillate and initial point of reflux.

From the scrubber drum the vapors from the crude



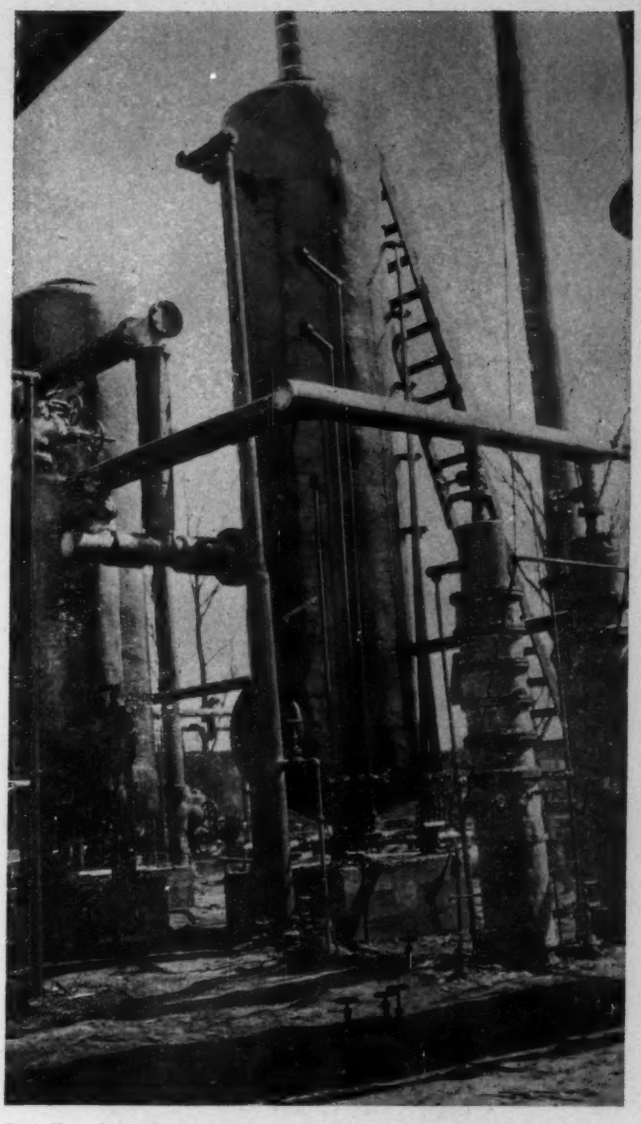
Fractionating equipment at El Dorado, Arkansas, refinery of McMillan Petroleum Products Company. Bottoms streams are removed from first two towers, and two streams taken from the last.

are conducted into the second tower, which is four feet by 25 in dimensions. This tower fractinates the lubricating oil distillate from naphtha and gas oil. Vapors of naphtha and gas oil boiling range pass overhead, and the lubricating oil fraction is removed as condensate from the bottom of the tower. The tower is equipped with a Foxboro automatic recording temperature controller which controls the volume of recycle stock which is sprayed into the tower near its top. Hot gas oil accumulating in the bottom of the next tower in the series is used as the spray stock.

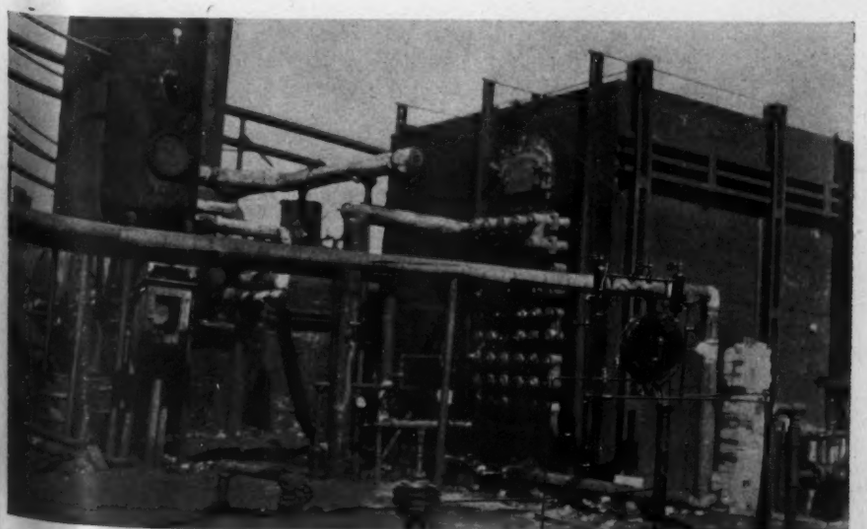
The lubricating oil distillate, for which there is a ready market, is very low in cold test, running zero to 10 F. It has a viscosity of 250 to 260 at 100 F. (Saybolt U.) and a flash test of 380 to 400. These specifications prevail when all of the lubricating distillate cut is removed from the tower as one cut. The tower is somewhat flexible in this respect since it is equipped with small lines for the removal of lubricating distillate from any one or any combination of the plates in the tower. These side streams when withdrawn make it possible for the operators to produce a number of grades of distillate ranging from 75 to 500 viscosity (100 F). One of the accompanying illustrations show the details of mechanical arrangement of equipment for the recovery of such side streams.

GRADES CONTROLLED

These small streams are conducted away from the tower into one or both of the flash sections as indicated in the photograph. In these sections the condensate withdrawn is flashed with steam to remove any light ends occurring in the distillate. The vapors derived from the flashing procedure are returned to the original tower through a vapor line provided for that purpose. The bottoms off the flash sections constitute the separate distillate cuts. The number of grades of lubricating oil distillate prepared by the company is governed by the market requirements. sufficient flash sections can be installed at very little cost to produce a number of grades constantly. At the time of the writer's visit all the distillate was being condensed in the original tower and withdrawn as one cut since prevailing orders called for a distillate of the specifications presented in the foregoing paragraph. No difficulty is encountered in the matter of securing color specifications. The entire distillate fraction has a pale lemon color, averaging 2 to 2½ color. Side streams also are secured with about the same color.



Details of hook-up for removal of side streams from bubble tower making lubricating oil distillate and flash sections for removal of any light ends with steam jet. Tank in rear at left is scrubber tank for vapors leaving stripper tower, equipped with automatic liquid level control device.



View of preheater coil and tube still, used in heating heavy Smackover crude to 690 degrees F. for vaporization of all products at one heating.

Temperature of the vapors at the outlet of the lubricating oil tower is 440 to 450. The last tower in the series, or naphtha tower, has an outlet temperature of 320 to 330 F. uniformly controlled by recording automatic temperature control instruments. Steam at 500 F. is used to a certain extent in all of the towers. For example the stripper or first tower is supplied at the bottom with steam at 70 to 75 pounds pressure at the rate of quar-

(*Continued on page 74*)

Refinery Operations Reflect Efforts To Control Output

By H. J. STRUTH
Petroleum Economist

THAT the refining industry is making definite progress in its efforts to control the output of refined petroleum products is exemplified by the results of its operations for the first 10 months of 1928. An analysis of refinery operations for the period beginning with January and ending with October, of this year, reveals that the aggregate quantity of crude run to stills was 26 million barrels less than the normal amount required to produce the gasoline demand for that period. On the basis of an average gasoline yield of 37.3 per cent. exclusive of natural gasoline blended, the normal quantity of crude required to produce the gasoline demand would have amounted to 778 million barrels. As a matter of fact, our refineries actually consumed 752 million barrels of crude during the first 10 months of this year; thereby preventing the production of an additional 9,698,000 barrels of gasoline that would have, otherwise, resulted in increasing surplus gasoline stocks to more than 36 million barrels on November first. Although market conditions during this period were not what could be termed extremely satisfactory, they showed considerable improvement over last year; obviously, as a result of efforts on the part of the refining industry to control its operations.

Figure 1 presents a striking example of what has been accomplished in the various refining centers during the first 10 months of this year. In this chart, refinery crude runs to stills are shown in relation to actual shipments of gasoline, on the basis of the respective percentage of gasoline recovery for the major refining areas. Thus we find that the entire industry managed to maintain a still run schedule that was not in any instance in excess of the normal gasoline demand; in fact, in most instances, runs were maintained at a somewhat lower level than actually indicated by the demand for gasoline. Since gasoline is the principal product of the refinery, it is logical to gauge still run operations according to the demand experienced for this product. Under each major refining district still runs of crude are expressed in percentage of normal gasoline demand; the normal demand line representing 100. In the accompanying table the figures upon which this chart is based are given for each of the refining districts.

H. J. STRUTH

H. J. Struth, well known pretroleum economist, has joined the staff of The Gulf Publishing Company at Houston. Until recently, Mr. Struth was editor of "Natural Gas," the official publication of the Natural Gas Department of the American Gas Association at Cincinnati, Ohio.

He has been identified with the oil and gas industry for more than 12 years and has been affiliated with several of the largest oil companies as an economist and statistician. Mr. Struth received his early training in the fields of Oklahoma and Kansas, as an employe of the Empire Companies.

He will specialize on oil industry economics and his articles will appear regularly in THE REFINER AND NATURAL GASOLINE MANUFACTURER.

REFINERY STILL RUNS SITUATION
FIRST TEN MONTHS OF 1928
(Millions of Barrels)

	Gasoline Produced			Crude Still Runs		
	Shipments	From Crude	% Yield	Required	Actual	%
East Coast	47.8	42.5	30.3	152.5	139.8	92
Appalachian	13.4	12.6	45.7	28.4	27.8	98
Indiana-Illinois	45.5	43.7	53.3	82.2	81.7	99
Oklahoma-Kansas	51.4	46.2	49.8	94.6	92.6	98
Texas	67.5	61.2	39.8	155.8	153.0	98
Louisiana-Arkansas	21.4	17.3	27.8	61.5	61.8	100
Rocky Mountain	14.4	12.6	57.8	23.0	21.6	94
California	57.5	44.6	25.7	185.9	173.7	93
Total United States	318.9	280.7	37.3	778.0	752.0	97

In order to determine the actual quantity of crude required to produce the gasoline demand, it was necessary to reduce actual shipments by the amount of natural gasoline used in blending. This resulted in a figure which represented the approximate quantity to be produced from crude and by cracking. These results are a decided improvement over operations of the past; particularly during the years 1921 to 1925, inclusive. Excessive still runs of the past have been mainly responsible for the unsatisfactory conditions which have prevailed during the past few years. Continued vigilence is, however, decidedly necessary if the refining industry expects to realize any benefit from the constantly growing demand for gasoline and other petroleum products. It is only by concerted effort that long-looked-for prosperity will become evident.

STOCKS LOW

On November 1, stocks of gasoline at refineries represented a shupply of 49 gallons per motor ve

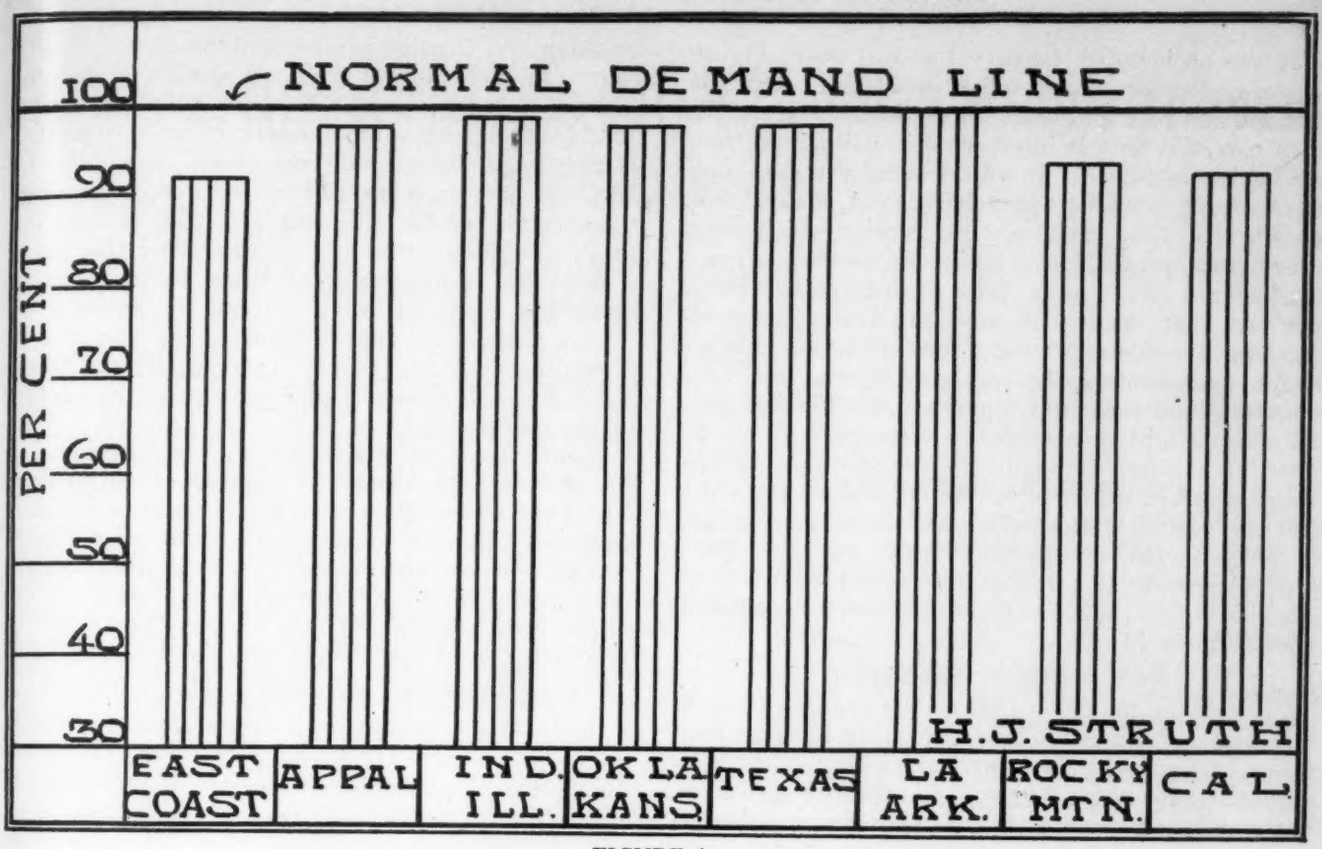


FIGURE 1

Refinery Crude Runs to Stills Expressed in Per Cent. of Normal Gasoline Demand. Shows how refineries have controlled their runs during the first 10 months of 1928.

hicle registered, the lowest point reached since 1921. It is not difficult to realize what might have happened if the refineries had run crude in excess of the normal gasoline demand. In fact, if refineries had run enough additional crude to exactly meet the gasoline demand, stocks of gasoline on November 1 would have aggregated an average of 67 gallons per motor vehicle instead of 49, or the same relative quantity

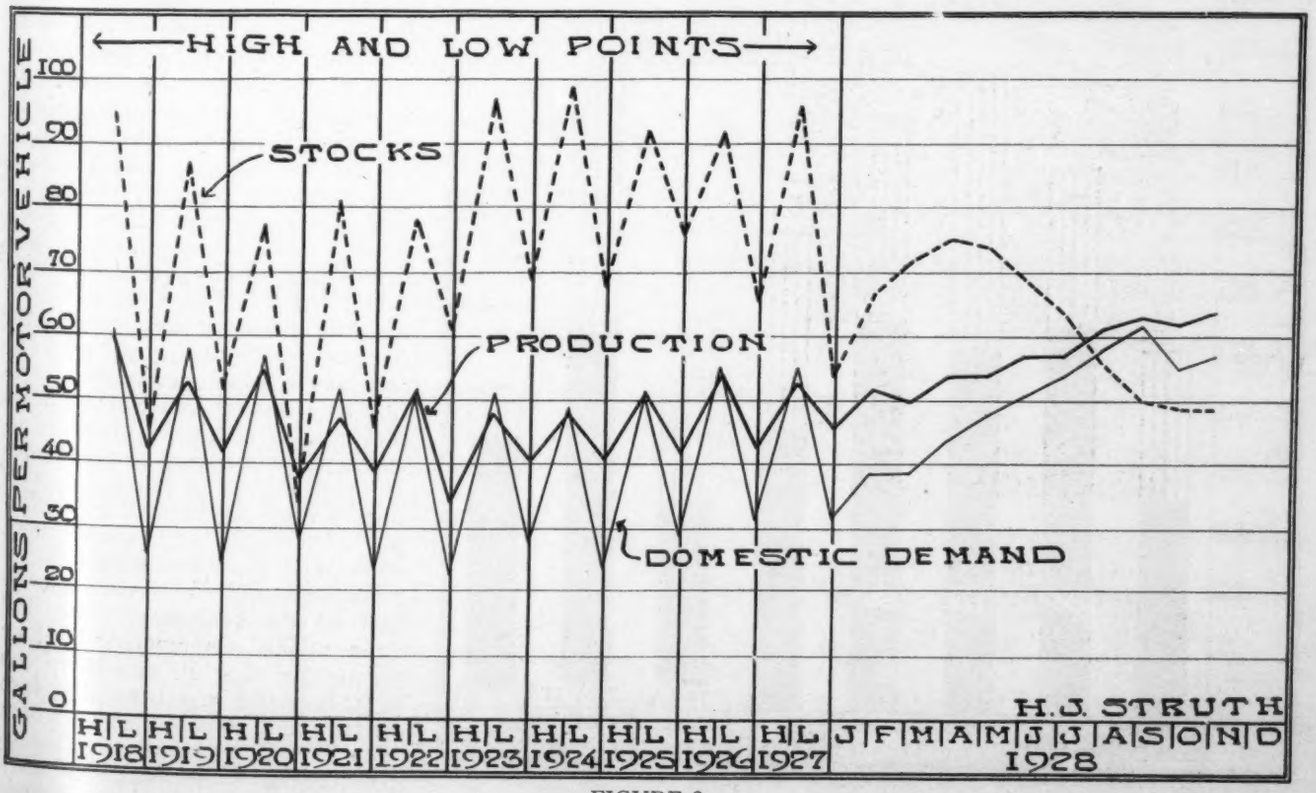


FIGURE 2

Gasoline Production, Domestic Demand and Stocks Expressed in Gallons Per Motor Vehicle Registered. Shows how stocks have declined with demand reaching highest le vels in history. Note upturn in production, for which cracking is mainly responsible.

that was on hand on January 1 of this year. Figure 2, shows the trend of gasoline production, domestic demand and refinery stocks for the last few years. In each case this data is interpreted in gallons per motor vehicle registered. It will be noted that although stocks have declined appreciably, and demand has grown at a more rapid rate per motor vehicle than ever before, production is beginning to show a more marked rate of increase. This is apparently due to the fact that, while still runs are being curtailed, cracking operations are more than offsetting this effect by accelerating the output of motor fuel. As matters stand now, it is apparent that further curtailment of still runs of crude is in order, since the yield of gasoline is beginning to turn sharply upward. Further evidence of this is obtained from the fact that the yield of gasoline has shown an increase of 2.81 per cent. during the last five months. During the month of October, the actual recovery of gasoline from crude was 38.99 per cent. as compared with 36.18 in May.

NOT ENOUGH CRACKING

Contrary to the belief that we are doing too much cracking at the present time, the writer believes that we are not utilizing this source of gasoline to the best economic advantage. Regardless of the fact that there is an overproduction of crude, the refining industry is entitled to a greater average yield of gasoline from crude, and cracking is the only sound method of insuring the greatest returns from every barrel of crude refined. A constructive movement on the part of the industry would be to run less crude and obtain the maximum yield of gasoline from every barrel by cracking the heavier products obtained by distillation. On November 1, refinery stocks of gas and fuel oil, including heavy California crude, aggregated 136,723,000 barrels. This supply is far in excess of market requirements and represents about 40 million barrels of gasoline, still leaving a more than adequate supply of domestic and industrial fuel oil. Refinery statistics for recent months show that many refiners are turning their attention to the cracking of surplus stocks of heavy oils and consequently reducing their still runs of crude. This may not be altogether desirable from the crude producer's standpoint, but it is sound economic practice on the part of the refiner.

Figure 3, shows what cracking has accomplished for the refineries in various sections of the country. This chart shows the percentage of gasoline recovery from crude for each of the major refining divisions, divided into the percentage recovered from straight crude distillation and the additional recovery obtained from cracking. The accompanying table contains the figures upon which this chart is based.

WHAT CRACKING HAS ACCOMPLISHED DURING 1928
(First Ten Months)

	Crude Run (M. Bbls.)	Straight Gaso. Prod. (M. Bbls.)	%	Cracked Gaso. Prod. (M. Bbls.)	%
East Coast	139.8	24.7	17.6	17.8	12.7
Appalachian	27.8	9.0	32.4	3.7	13.3
Indiana-Illinois	81.7	24.8	30.2	18.9	23.1
Oklahoma-Kansas	92.6	30.1	32.5	16.1	17.3
Texas	153.0	35.3	23.2	25.3	16.6
Louisiana-Arkansas	61.8	11.0	17.5	6.3	10.3
Rocky Mountain	21.6	6.8	31.1	5.8	25.7
California	173.7	39.1	22.6	5.5	3.1
Total United States	752.0	180.5	24.0	99.4	13.3

If it were not for the cracking process, the yield of gasoline from crude during the first 10 months of this year would have been only 24 per cent. This means that we would have required the distillation of 1,210,000,000 barrels of crude, or 458 million barrels more than was actually consumed. At this rate, stocks of crude would now be entirely exhausted and the industry would become panic stricken over its inability to maintain an adequate output of crude to supply the refinery demand. Naturally, this condition would result in waste that would soon exhaust every available source of petroleum. Under present conditions it would seem logical for the refining industry to function as a separate unit, acting as an independent purchaser of crude petroleum. It is not up to the refining industry to attempt to solve the producer's problems by limiting the output of gasoline and, consequently, consuming more crude than is economically required. As a matter of fact, if the refining industry had fully utilized its cracking facilities during the first 10 months of this year, it would have been possible to curtail crude runs to the extent of at least 30 million barrels more than the actual results show. Since it is known that the gasoline yield from crude can still be considerably increased, it

(Continued on page 73)

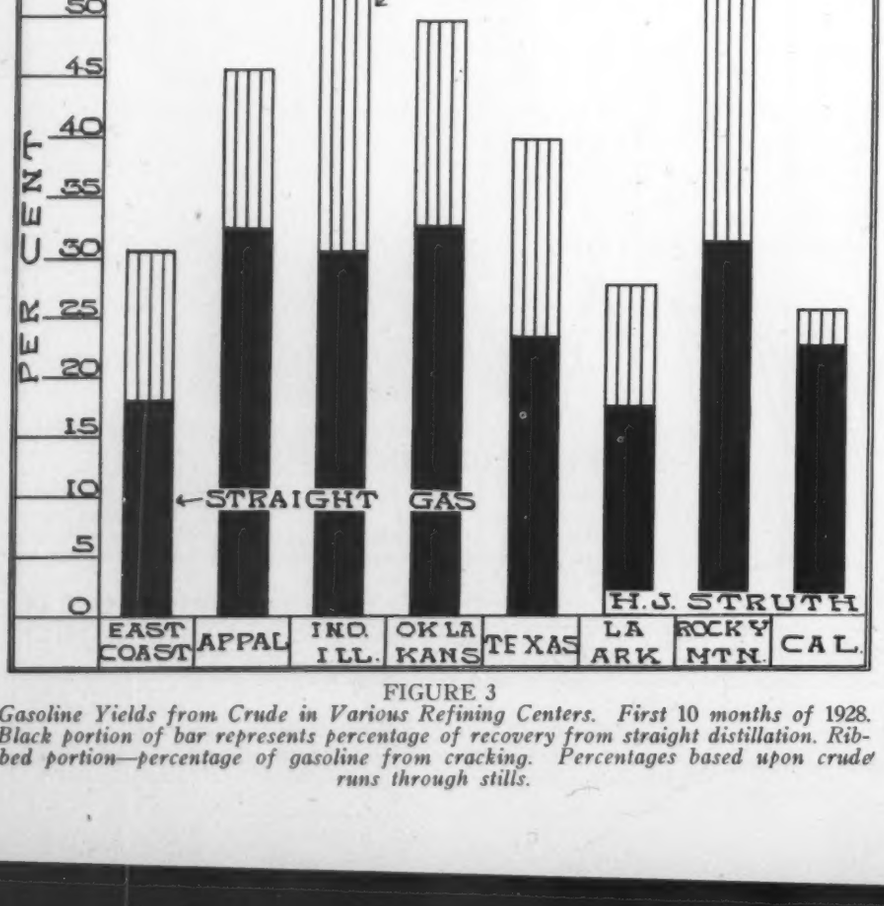


FIGURE 3

Gasoline Yields from Crude in Various Refining Centers. First 10 months of 1928. Black portion of bar represents percentage of recovery from straight distillation. Ribbed portion—percentage of gasoline from cracking. Percentages based upon crude runs through stills.

A Graphical Analysis of Distillation Problems*

By E. G. RAGATZ
Union Oil Company

IN the graphical analysis of distillation relationships as outlined by McCabe & Thiele[1], with its recent amplification in the field of countercurrent absorption systems by Lewis and McAdams[2], we have an analytical method which can be effectively used in solving many of the absorption and distillation problems confronting the natural gasoline industry. As with most graphical methods, this one presents a flexibility and simplicity lacking in the analytical methods usually employed for the solution of distillation problems. At the same time the assumptions upon which it is based are few, and direct, and hold to a remarkable degree in modern absorption plant practice. All in all, it is a tool which the engineers of the industry can ill afford to neglect.

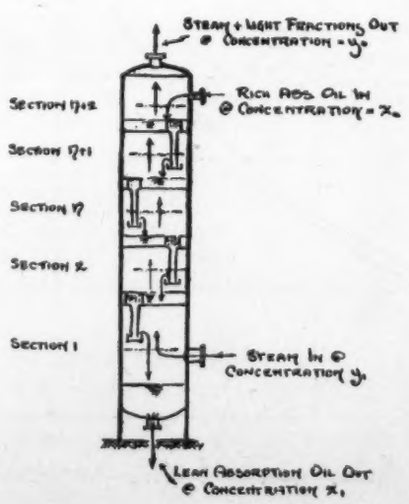
This analysis, as applied to a conventional plate type absorption or distillation solumn, derives its effectiveness from the following experimentally determined relationships:

1. The layout of such a conventional plate type column can be developed from a theoretical unit in which the down flowing reflux comes to complete vapor pressure equilibrium with the ascending vapors on each plate.
2. The ratio of the theoretical number of plates to actual number of plates required to obtain a given result for any one general type of operation will remain substantially constant; this constant usually being referred to as the plate officiency.

In outlining this graphical method we will first discuss the general "assumptions of state" required for its validity, and then develop the simple relationships upon which the analysis itself is based.

*Read before the California Natural Gasoline Association at Los Angeles, November 13 and 14, 1928.
[1](McCabe & Thiele, Ind. Eng. Chem. 17,605 (1925).
[2](Lewis & McAdams, Ind. Eng. Chem. 20,253 (1928).

FIGURE A.
A SIMPLE PLATE STRIPPING COLUMN.



OPERATING ASSUMPTIONS

In figure "A" we have illustrated a conventional plate type of simple stripping column for the graphical analysis of which we must make the following general operating assumptions:

1. The pressure and temperature of the vapor stream flowing through the column must be constant and uniform. This implies that the pressure gradients through the various plates are negligible, and that the latent heat of vaporization of the light fractions, together with any air losses, is compensated for by some heating device other than the stripping steam stream. These assumptions correspond closely to the conditions existing in the exhausting sections of many modern vertical steam stills.
2. The column is fed continuously with a uniform quality of material, and produces a constant quantity and uniform quality of lean bottoms and rich overhead while using a constant quantity of steam of uniform quality. These uniform conditions, of course, are those met with in the operation of any well regulated continuous still.
3. The absorption oil is fed to the still at a temperature corresponding to the aforementioned uniform still temperature.
4. The exchange of light material between the descending liquid absorption oil and the ascending vapor stream occurs only on the column plates.

From the above assumptions it is obvious that any solute (light fraction) given up by the absorption oil must be taken up by the stream, and furthermore, that this exchange must take place at a uniform rate on each plate of the column. Then, calling the concentration of solute in the liquid X, and in the steam Y, and the quantities of absorption oil and steam handled per unit of time, respectively, O and S, we note that between any section n, and the top of the column:

The solute given up by the absorption oil per unit of time=

$$\Delta X = O (X_0 - X_n)$$

The solute taken up by the steam per unit of time=

$$\Delta Y = S (Y_0 - Y_n)$$

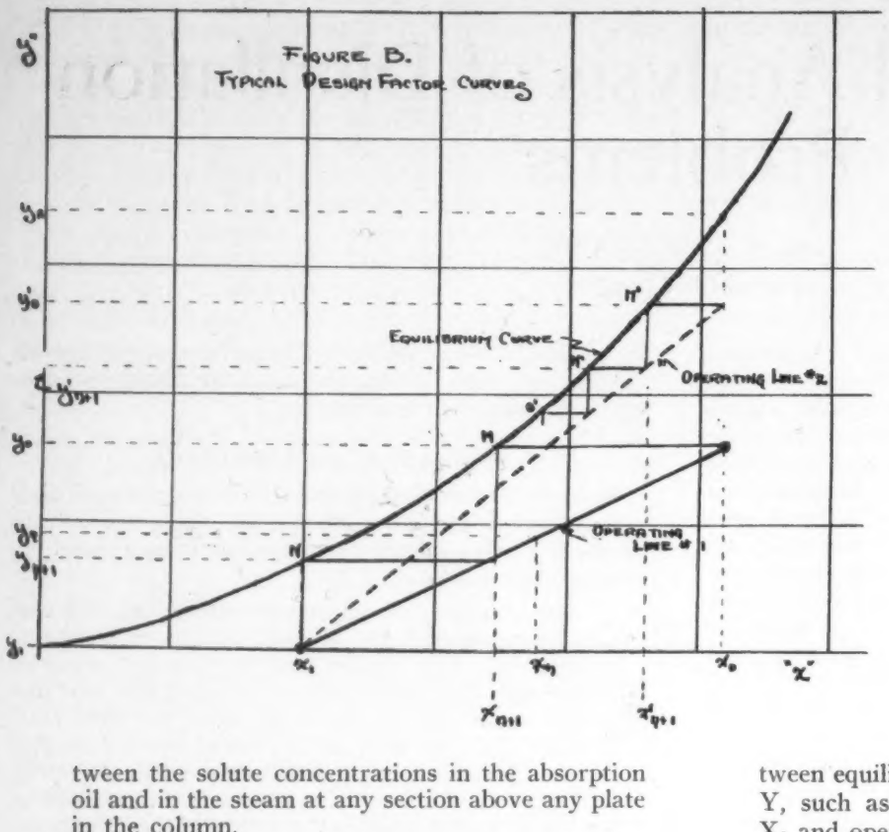
Equating the above expressions gives

$$O (X_0 - X_n = CS (Y_0 - Y_n)$$

Where C = Some constant.

Now from this very simple fundamental relationship, we may draw two extremely important deductions:

1 Since this equation was derived simply by equating input against output, it expresses a perfectly general state of affairs, and may be applied to any column operating under the limitations imposed by the above outlined assumptions. Furthermore, it accurately expresses the relationship existing be-



tween the solute concentrations in the absorption oil and in the steam at any section above any plate in the column.

2. The concentration of solute in the steam, "Y," is linear in "X," the concentration of solute in the oil. In other words, if we plot values of Y vs. X for various sections through the column, the curve defined by these points will be a straight line.

In the analysis developed by McCabe & Thiele a graph is employed, the co-ordinates of which are X and Y expressed in any convenient terms. On this graph a curve is plotted from the above general equation. This curve (a straight line) is called the operating line, since it interprets the character of operation occurring within the column. In conjunction with this operating line they also utilize a second curve called the equilibrium curve. This second curve indicates, for various solute concentrations, the simultaneous value of X and Y required to develop vapor pressure equilibrium between the solute fraction in the absorption oil and the solute in the stripping steam. A set of these curves is illustrated in figure "B."

CALCULATIONS

Referring to figure "B," let us assume that the column of figure "A" is to operate with a continuous feed of uniform quality X_o, which feed is to be stripped to bottoms quality of X_1, and that the equilibrium curve of figure "B" represents the simultaneous solute concentrations required for the maintenance of pressure equilibrium between the liquid and vapor phases of the solute in question. Then—

1. For any value of X, such as X_o, the corresponding Y equilibrium concentrates equals Y_o.
2. With the entering steam assumed to contain zero concentration of solute, the point X_1—Y_1 of the operating line is fixed.
3. Although the X value of the upper end of the operating line is fixed at X_o, its Y value has not yet been defined, and hence a whole series of operating lines similar to lines numbers 1 and 2 may be drawn.
4. As the slope of these operating lines increases, the operating line values of Y increase for any given value of X, thus indicating an increasing concentration ratio of solute in the steam.
5. Obviously the difference between equilibrium and operating concentrations of Y, such as Y_o—Y_o for the liquid concentration X_o and operating line No. 1, indicates the driving force which transfers the solute from the absorption oil into the stripping steam.
6. Therefore, if the operating line should touch the equilibrium curve, no driving force would be present to change the concentrations of solute at this

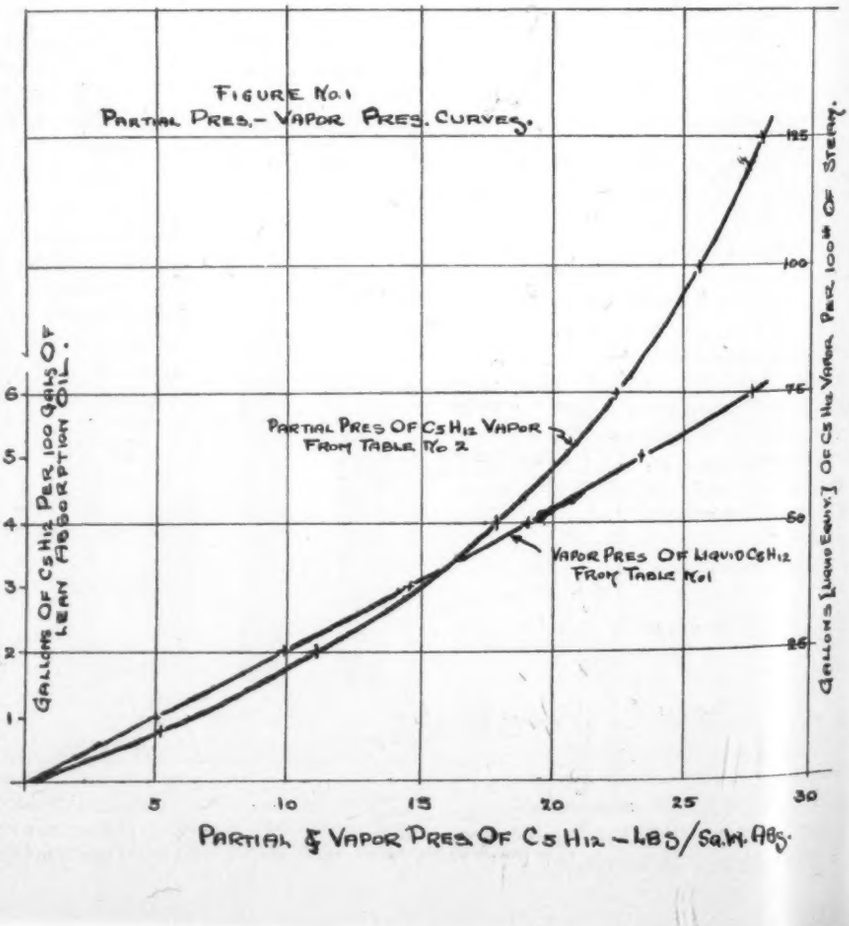
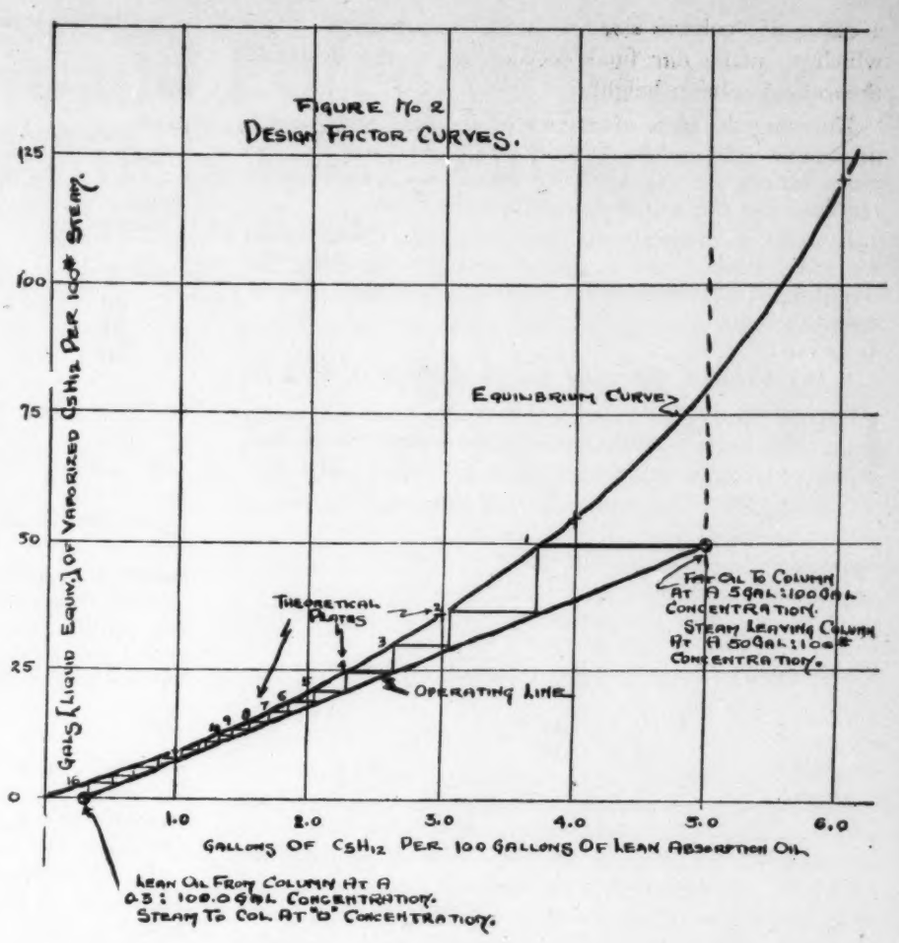


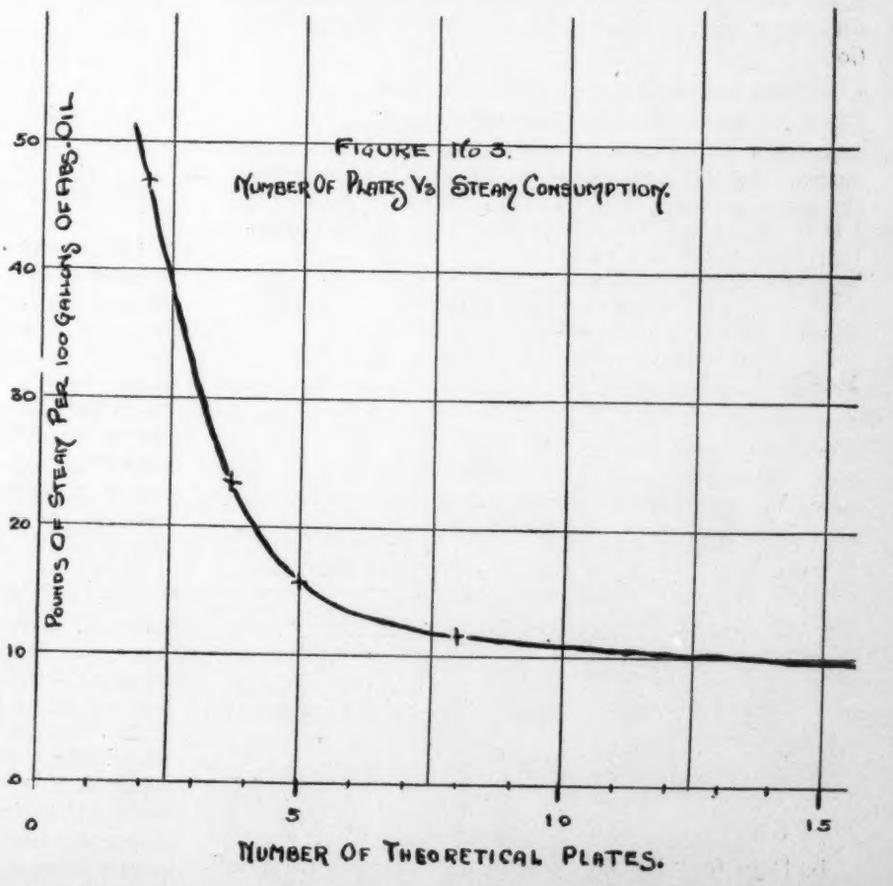
FIGURE No.1
PARTIAL PRES.- VAPOR PRES. CURVES.
GALLONS OF C5H12 PER 100 GALS OF LEAN ABSORPTION OIL.
GALLONS LIQUID EQUIV. OF C5H12 VAPOR PER 100# OF STEAM.
PARTIAL PRES OF C5H12 VAPOR FROM TABLE No 2
VAPOR PRES OF LIQUID C5H12 FROM TABLE No1
PARTIAL & VAPOR PRES OF C5H12 - LBS/SQ.IN. ABS.

tangent point, and the column would become inoperative in this region.

7. Furthermore, if the operating line should cut over the equilibrium curve, the differential of solute pressure would be reversed, and the solute would tend to migrate from the stream back into the absorption oil. This, of course, is an impossible condition, and hence the "slope of tangency" must be the upper limiting slope of the operating line.

With these observations in mind, let us recall the originally stated rule that the actual column design can be based on a theoretical unit in which complete pressure equilibrium is established at each plate. If that is the case, and operating line No. 1 represents the column operation, then Y_o represents the concentration of solute in the steam leaving the column, and the equilibrium value of "X" for Y_o is the concentration of the liquid on the top plate, this top plate concentration being indicated by X^n+1. Hence we see that "top plate" conditions of equilibrium are expressed by the point M on the equilibrium curve. However, the oil from the top plate, in descending to the plate second from the top, passes through section n+1 where it must be in phase with the vapor stream as indicated by operating line No. 1. This operating line relationship then establishes the value of Y^n+1 as the concentration of the vapor ascending from the second plate. But these vapors must, in turn, be in equilibrium with the oil on the second plate as again indicated by the equilibrium line. Hence point N represents the equilibrium status at the second plate. Now from this development of points M and N, it should be obvious that each such point of equilibrium implies the presence of a single theoretical plate, and herein lies the solution of your simple stripping still problem—the slope of the operating line determines the exit steam concentration of solute, and hence steam consumption rate, while the step-wise construction between the operating line and the equilibrium curve indicates the number of theoretical plates required to effect the desired separation.





REQUIRED SPECIFICATIONS

For the conditions of operating line No. 1 we see that we would require two theoretical plates. But by inspection we also see that line No. 2 would use less steam and require more plates than line No. 1. Now for the solution of any given still problem, we should first construct several operating lines, calculate the steam rate required for each respective number of plates used. and then plot

a curve of "column size vs. steam consumption" from which to make our final decision as to the desirable theoretical column height.

Knowing the plate efficiency of the particular design of column used and its capacity per square foot of gross cross action, we can then lay down the specifications required for the actual column construction.

In order to illustrate the foregoing general discussion we have worked out a simple problem involving the stripping of a pentane fraction from a typical 42 gravity absorption oil.

1. Given:
   - (a) Column operating continuously at a uniform rate.
   - (b) Total absolute pressure on column = 45 lbs.
   - (c) Temperature of column uniform at 325° F.
   - (d) Rich absorption oil and steam fed to column at 325° F.
   - (e) Absorption oil:
     40.0° A. P. I.
     6.87 lbs. per gal.
     175 Mol Weight
   - (f) Light oil fraction (Pentane):
     92.4° A. P. I.
     5.27 lbs. per gal.
     72 Mol Weight
     275 lbs. vapor pressure at 325° F.
   - (g) Fat oil contains 5 gallons of C_5H_{12} per 100 gallons of Absorption Oil.
   - (h) Lean oil contains 0.3 gallons of C_5H_{12} per 100 gallons of Absorption Oil.

2. Required: A curve showing the relationship between number of theoretical plates and steam consumption required for reducing the fat oil to a 0.3 concentration.

3. First calculate the data for the "partial pressure-vapor pressure curves" of figure No. 1.

a. Data for "Vapor Pressure vs. Fat Oil Saturation" curve. Make this curve on the basis of the variation in the vapor pressure of C_5H_{12} as its saturation varies from 1 to 6 gallons per 100 gallons of absorption oil, assuming that Raoult's Law is valid.

$$\text{Mols/100 gallons absorption oil} = \frac{100 \times 6.87}{175} = 3.92$$

$$\text{Mols/Gal. } C_5H_{12} = \frac{5.27}{72} = .0732$$

Vapor pressure of various C_5H_{12} saturations X.

$$V.P. = \frac{.0732\,X}{3.92 + .0732\,X} \times 275 = \frac{20.1\,X}{3.92 + .0732\,X} \quad \text{——(1)}$$

Where X = Gals. of C_5H_{12} per 100 gallons of lean absorption oil.

TABLE NO. 1

X	20.1 X	.0732 X	V.P
1.0	20.1	.073	5.0
2.0	40.2	.146	9.9
3.0	60.3	.220	14.7
4.0	80.4	.293	19.1
5.0	100.5	.366	23.4
6.0	120.6	.439	27.7

b. Data for "Partial Pressure vs. Steam Saturation" curve. Make this curve on a basis of the variation in the partial pressure of C_5H_{12} as the vapor concentration varies to give partial pressures of C_5H_{12} between 5 lbs. and 30 lbs. per 100 lbs. of steam, assuming that the perfect gas laws are valid.

$$\text{Mols/100 lbs. steam} = \frac{100}{18} = 5.56$$

$$\text{Mols/Gals. } C_5H_{12} = \frac{}{0.0732}$$

Partial pressure of various C_5H_{12} saturations Y.

$$P.P = \frac{0.0732\,Y}{5.56 + 0.0732\,Y} \times 45 = \frac{3.29\,Y}{5.56 + 0.0732\,Y} \quad \text{——(2)}$$

Where Y = Gals. (Liquid equivalent) of C_5H_{12} vapors per 100 lbs. steam.

TABLE 2

Y	3.29 Y	0.0732 Y	P.P.
10	32.9	.73	5.2
25	82.3	1.83	11.2
50	164.5	3.65	17.9
75	247.0	5.48	22.4
100	329.0	7.32	25.6
125	412.0	9.14	28.0

4. Draw equilibrium curve of figure No. 2. From the data in tables No. 1 and No. 2 construct the curves shown on figure No. 1 and then construct the equilibrium curve on figure No. 2 by plotting equivalent points of equal C_5H_{12} pressure from figure No. 1.

Note that for this simple case we could have plotted the equilibrium curve directly by equating formulas 1 and 2 and solving for Y, obtaining thereby an equation for the equilibrium curve of

$$Y = \frac{11.5\,X}{12.9 - 1.23\,X}$$

However, in more complex problems, the two pressure curves of Figure 1 must be constructed for the development of the equilibrium curve, and hence they are included in this simple case as a matter of illustration.

5. Draw various operating lines and obtain data for figure No. 3. With the equilibrium curve drawn, and fat and lean oil concentrations fixed, we can draw a series of operating lines similar to the one on Figure 2, and determine the steam rates for various numbers of trays—from these data then plot the curve of figure No. 3.

For the operating line on figure No. 2:
- (a) Use 2 lbs. steam/gallon C_5H_{12} in the vapors.
- (b) Remove 5.0-0.3 = 4.7 gals. C_5H_{12} per 100 gals. abs. oil.
- (c) Steam Rate = (2 x 4.7) + 100 = .094 lbs. of steam per gal. absorption oil.
- (d) Require 16 theoretical plates.

6. Plot the curve of figure No. 3. Curve No. 3 indicates that we can use a minimum steam rate in the order of 10 pounds of steam per 100 gallons of absorption oil and still obtain the desired absorption oil leanness. Such a steam rate, however, requires the use of 14 to 16 theoretical plates. Now if we reduce the number of plates to 7 or 8, the steam rate per 100 gallons of oil will only be increased by about one pound. In other words, a 50 per cent reduction in column height would increase the steam rate only 10 per cent. Obviously, the use of the shorter column would, in most cases, result in a more economical design.

Although the foregoing problem is an extremely simple one, it illustrates a method which is capable of extensive elaboration in the analysis of many rather complicated distillation operations. From our point of view, its real value lies in the possibility it presents of using data from one operation for the prediction of the layout required for an allied, though quite differently detailed, operation.

In all such cases, sufficient data must be obtained from the first operation to define the efficiency of the plates being used, and to permit of drawing the "partial pressure-vapor pressure" curves for the second operation. Once having these preliminary curves established, it is then an easy matter to develop the equilibrium curve of figure No. 2 and complete the graphical analysis of the problem.

The Present and Potential Market For Oil Fuels for Heating

By TRELL W. YOCUM
Oil Heating Institute

I BELIEVE that the subject of this paper, "The Present and Potential Market for Oil Fuels for Heating," not only lies close to the heart of every oil man but also to his pocketbook.

There are three things about which I want to talk to you:

1. The present status of fuel oil consumption in the United States.
2. What is being done to increase the consumption of fuel oil, with particular reference to commercial and domestic oil burner markets.
3. What can be done to further develop markets for fuel oil during 1929.

For the first time we have authentic figures on the use of fuel oil for heating homes and large buildings. With the recent publication of the United States Bureau of Mines National Survey of Fuel Oil Distribution, which was made in cooperation with the American Petroleum Institute, we have available authentic fundamental data for estimating the number of domenstic and commercial oil burners in use in the past and at the present time.

Using these figures we have made calculations which, we believe, give an accurate picture of the oil burner industry, and which also points toward the definite trend of the expanding market for fuel oil.

If, as Mr. Walter C. Teagle contended before the Federal Oil Conservation Board in 1926, the price of fuel oil has ceased to be incidental and has become a real factor in the detremination of the value of a barrel of crude—then these figures mean something to every oil company in this country—whether marketers of fuel oil or not.

Please keep in mind that the term domestic oil heating refers to the application of oil burners in connection with central heating plants of homes and including small apartment buildings. The term commercial oil heating is used to classify application of burners for the heating of large apartments, office buildings, theaters, schools and similar buildings. This term should not be confused with industrial oil burning, which is used to classify applications for developing steam for industrial power and also the application of burners for industrial processes, such as heat treating, drying-ovens, etc.

These figures do not include the so-called stove burners, which are used in cook stoves, base burners and similar devices. There are a great number of these in use, which in the aggregate consume a quantity of kerosene and the lighter distillate furnace oils. These devices, however, cannot be considered as in the same classification with domestic oil burners for central heating plants.

Using the figures in the Survey of the Bureau of Mines for the years 1923 and 1927, we have made an analysis, giving the number of barrels of oil used each year from 1921 to 1928, for both mechanical or forced draft, and natural draft or non-mechanical burners. These figures are also broken down into two fuel classifications of light distillate furnace oil, approximately 38 degrees Baume, and the heavy distillate furnace or gas oil, approximately 28-36 Baume.

GROWTH OF USE

In the year 1921-22 there was a total of 600,000 barrels of oil consumed for domestic and commercial heating—of which 500,000 was light furnace oil and 100,000 heavy furnace or gas oil. In the year 1925-26 there was a total of 8,830,000 barrels consumed—of which 6,860,000 was light furnace oil and 1,970,000 was heavy furnace or gas oil. For the heating season of 1928-1929, projecting these curves, we find there is an estimated total of 23,538,000 barrels of fuel oil—of which 10,038,000 barrels are light furnace oil and 13,500,000 barrels are heavy furnace or gas oil.

In order to obtain the number of burners operating, we have used the above mentioned oil figures by assuming an annual consumption of 60 barrels for mechanical draft burners and 40 barrels for natural draft burners.

Projecting these curves both backward and forward, we reach a total of 12,500 burners operating on January 1, 1921, of which 5000 were mechanical draft and 7500 were natural draft. In 1926 these same figures give a total of 169,400 burners in operation, of which 113,900 were mechanical and 56,500 were natural draft. The estimated total of burners to be used in domestic oil heating in operation on January 1 of the coming year is 422,700, of which 331,500 are mechanical draft and 91,200 natural draft. I would like to add that these figures have been cross-checked by the largest control manufacturer and this check indicates that the estimates of total domestic burner figures are approximately correct. You will recognize that the total number of burners now in operation is less than many previous estimates. If we have erred in making these estimates we believe that it is on the side of conservatism. While these totals are smaller than the estimates which have gone before, nevertheless the actual market, both for oil companies and for burner manufacturers is thereby the larger.

COMMERCIAL BURNERS

There is less information concerning oil used for commercial oil heating, figures being available only for 1926 and 1927. According to the United States Bureau

of Mines, there was a total of 27,800 commercial installations in operation during the heating year 1926-27, which consumed a total amount of 13,875,000 barrels of fuel oil. During the heating year 1927-28 there was a total of 30,300 installation which consumed 15,-145,000 barrels of fuel oil. By projecting this curve back to the year 1925-26, we get a total number of installations of 24,000 with a fuel oil consumption of 12,-000,000 barrels. By projecting the same curve forward, we get for the heating year 1928-29, 33,500 installations with an estimated fuel oil consumption of 16,750,000 barrels. It is estimated that there is an average of one and one-half to two burners per installation, and these estimates on the consumption of fuel oil are based on an average of 500 barrels per annum per installation. One point is brought out very forcibly from these figures—namely, the large amount of oil consumed for commercial heating in comparison with the number of installations. We believe that this indicates the importance of developing this field.

The figures that we have show that the total consumption of fuel oil for domestic and commercial heating in 1924 was nearly 15,000,000 barrels, or slightly less than four per cent. of the total for all uses. We now find that the 1928 consumption in this same field is increased to 40,288,000 barrels, or approximately 10 per cent. of the total fuel oil used in the United States this year.

The chart we have prepared is based on the 1927 Survey of the Bureau of Mines, and shows graphically the five largest users of fuel oil in comparison with commercial heating and domestic heating for 1926 and 1927. If we combine the figures for commercial and domestic heating, we find that a larger percentage is used in this combined field than is used in the iron and steel industry.

In our analysis work we plotted a curve which was projected to give the estimated consumption for the year 1928, which is shown in the column on the right-hand side of the chart and indicates that the consumption of oil for commercial and domestic heating will be practically 10 per cent of the total fuel oil used, making this the fourth largest individual market in the country. By intelligent development it should rank at or near the top in the course of the next few years.

To clarify my second point: "What is being done to increase the consumption of fuel oil, with particular reference to commercial and domestic oil burner markets," I shall sketch very briefly some of the major activities of the Oil Heating Institute, which is supported jointly by the oil industry and the more important burner manufacturers.

THE ACTIVITIES OF THE OIL HEATING INSTITUTE

During 1926 the American Oil Burner Association carried on a most successful sales stimulation campaign. With this completed program as a basis for a more thoroughly organized and comprehensive joint effort, a majority of the leading manufacturers who were members of the association founded the Oil Heating Institute in April, 1927.

The purpose of the Institute was to carry on research, educationl and publicity work on oil heat. Its most immediate activity was to concern itself with a nationwide educational program showing the public why oil heating is the modern miracle of heating comfort; why the industry has grown more rapidly in its first 10 years than the automobile industry grew in its first 10 years; and that this method of heating will continue to show substantial growth. It was also to serve as a central bureau of oil heating information, where anyone interested may secure accurate unbiased facts and advise on this modern way of providing clean and automatic heat; to supply information to home and building owners, and technical and trade information to such groups as architects, building and heating contractors, fire authorities, oil marketers and others who may need it.

The Institute has been functioning for a year and a half. The results of a large part of its work it is impossible to trace. There have, however, been gathered to gether in the following pages facts and figures that will at least show the different fields of its activity and give some indication of the results that have been obtained.

ADVERTISING

Since June, 1927, the Oil Heating Institute has carried on an advertisinng program in magazines of national circulation whose readers make up a logical market for oil heating equipment. The total circulation of the magazines used is slightly over 12,000,000. Copy and art appeal for these advertisements have been designed to sell home owners the idea of oil heat and to convince them that the era of perfected automatic oil heat is here —with all of its relief from worry and dirt and drudgery.

A large share of Institute expenditure has been in this kind of display advertising. In addition to advertising in general magazines, there has been carried on a consistent advertising program in those trade and professional magazines for whose readers we had a particular message.

During both years of its activity, the Oil Heating Institute has supplied to interested oil companies "Heat with Oil—the Modern Fuel" cards for display at filling stations. Eighteen thousand of these cards have been distributed to all parts of the country through the sales departments of oil companies.

To enable dealers to capitalize upon the work of the Institute, every dealer handling equipment manufactured by a member of the Institute is supplied with a window display card bearing the Institute emblem and certifying the fact that the burner sold there is manufactured by a member of the Oil Heating Institute.

INSTITUTE BOOKLETS

During 1927 the Institute distributed, in response to inquiries, 15,000 copies of "Oil Heating—The Modern Miracle of Comfort," an 80-page booklet on oil heat and the way to select oil heating equipment. During the latter part of 1927 a canvass was made among home owners to determine, in so far as possible, their major objections to oil heat. As a result of this investigation, and to meet these particular objections, the Institute published in the early part of 1928 four new booklets:

1. "Are Oil Heaters Perfected?"
2. "Does It Pay to Install an Oil Heater?"
3. "What About the Supply of Oil Fuel?"
4. "Making Better Use of the Basement."

About 25,000 of these booklets have already been distributed in response to direct requests for them.

ARCHITECTS

The biggest influencing factor in the selection of heating equipment is the architectural profession. At the start of 1927 program a special bulletin, "A New Organization," was sent to 7200 architects, announcing the Institute and the technical service it offers, showing the growth of the industry and the increasing demand for oil heating. Early in 1928, 25 leading architects in the Metropolitan New York area were personally interviewed. This, and other investigations, disclosed the need for a concise booklet that would give to the architect the information that he wanted about oil heat. As a result, the Institute named C. Stanley Taylor, a well-known architect and consultant on building materials, to write "Installing Oil Heat—From the Architect's Point of View." A copy of the completed brochure was sent to over 8000 architects in the United States and Canada.

The traceable result of this work with architects have been most gratifying. The first edition of 15,000 copies of "Installing Oil Heat" has been completely exhausted.

BUILDERS

The largest buyers of oil heating equipment which the Institute can reach are the speculative builders and the building contractors—the men and the companies who are erecting buildings and supervising the installation of heating plants every day throughout the year.

Ten thousand of these received regularly during 1927 specially prepared bulletins showing the advantages of oil heat and giving performance records in actual installations.

During 1928, 5000 copies of "Making Better Use of the Basement" have been distributed to these builders, and we have had written inquiries for additional information from many in 32 different states. The demand for information about commercial installations of oil heating equipment has been especially large.

In addition to builders and building contractors we have mailed to 5000 heating contractors special bulletins on the advantages of oil heating and the possibilities in the market for oil heating equipment.

CITY OFFICIALS

Fire marshals and other city officials in 1602 cities of over 5000 population have given us interested cooperation and supplied valuable records in our efforts to get information on the fire hazards of oil heating. Several fire marshals expressed the opinion that oil heating is safer than heating with solid fuels. All of them asked for a complete report of the investigation, which they received in "The Increasing Use of Oil Fuel for Safe Heating."

In this connection, the Institute checked closely over a period of six months newspaper reports of fires caused by oil burners. Whenever such a fire was reported, a questionnaire was immediately mailed out to the chief of the fire department in the city where the fire occurred and to the owner of the building. Seventy-three per cent. of the questionnaires returned to the Institute during this period of investigation showed that the fire had been falsely reported. In many cases there had been no oil burner on the premises where the fire occurred.

COMMERCIAL INSTALLATIONS

As a part of its 1928 program, the Institute last summer published a series of eight folders giving the facts, with actual performance records, of the oil for heating commercial buildings.

"Oil—The Modern Heat for Hospitals"
"Oil—The Modern Heat for Hotels"
"Oil—The Modern Heat for Apartment Houses."
"Oil—The Modern Heat for Theatres"
"Oil—The Modern Heat for Office Buildings"
"Oil—The Modern Heat for Department Stores"
"Oil—The Modern Heat for Schools"
"Oil—The Modern Heat for Clean Cities"

Copies of these folders were distributed with a letter to interested factors, as follows: 5000 superintendents of hospitals; 6000 managers of hotels; 5000 operators of apartment houses; 2500 operators of theaters; 2500 operators of office buildings; 1000 operators of department stores; 2200 presidents of boards of education; and 3314 city officials.

DEALERS

Since its organization, the Institute has maintained a regular bulletin service to the thousands of dealers all over the country who are handling equipment manufactured by members of the Institute. Regular bulletins go out one a month, and, in addition, special bulletins as the occasion for them may arise. The purpose of this direct-mail contact with dealers has been twofold: to gain their confidence in the Institute and the work that it is doing; to help them to capitalize upon the advertising and educational work of the Institute in increasing their sales.

UNIVERSITIES

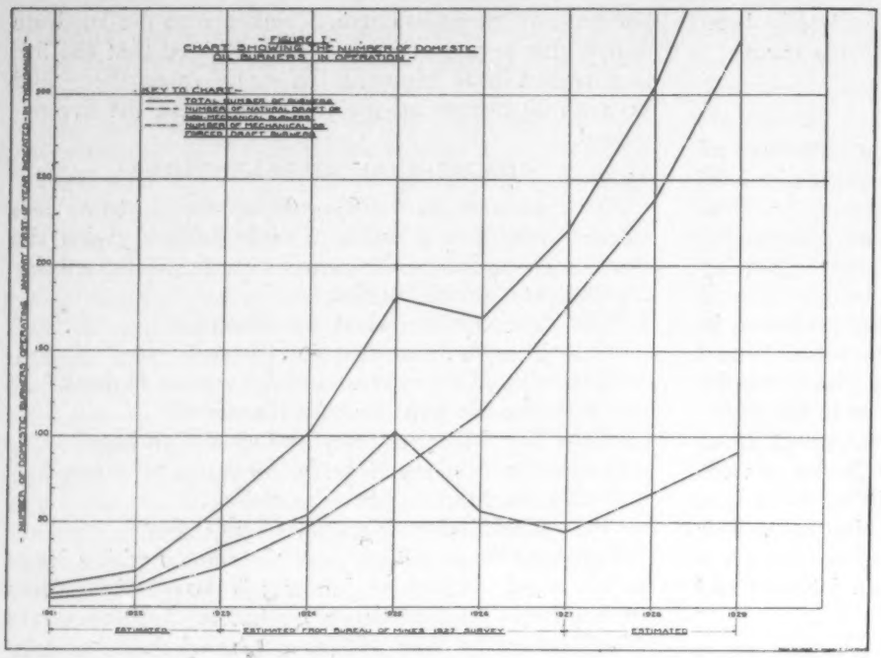
It has been part of the plan of the Oil Heating Institute to maintain close contact with professors in colleges and universities which maintain departments of heating engineering. As a result of our efforts along this line, several of these professors have referred their students to us for authoritative information on oil heat for use in their courses of study.

In addition to the foregoing, we conduct a definite publicity program which touches the general and trade magazine fields, daily and weekly newspapers, etc., etc., the ramifications of which I will not go into at this time.

RESEARCH

With the cooperation of the research department of William Green, Inc., and Lord & Thomas and Logan, the Institute has just completed a study of the status of the oil burner industry and its market possibilities. The purpose of this investigation was to aid the Institute and its members in the intelligent planning of sales and advertising programs. The survey is divided, roughly, into three divisions:

1. *An analysis of the national market for oil heating equipment.* This information is being broken down so as


- FIGURE I -
CHART SHOWING THE NUMBER OF DOMESTIC OIL BURNERS IN OPERATION -
- KEY TO CHART -
TOTAL NUMBER OF BURNERS
NUMBER OF NATURAL DRAFT OR NON-MECHANICAL BURNERS
NUMBER OF MECHANICAL OR FORCED DRAFT BURNERS
- NUMBER OF DOMESTIC BURNERS OPERATING AMOUNT ONLY AT YEAR INDICATED IN THOUSANDS -
ESTIMATED
ESTIMATED FROM BUREAU OF MINES 1927 SURVEY
ESTIMATED

to be applicable not only to states, but to counties within the several states. Such factors as the varying prices and distribution of gas, coal and oil; Standard of Living; Wealth; Growth of Population; Concentration of Population; etc., are being taken into consideration.

2. *An analysis of factors within the industry.* In an effort to secure information that will lead toward valuable conclusions in this respect, personal interviews are being obtained with men in every industry allied to the oil heating industry. In addition, questionnaires have been mailed to the following groups: 581 oil burner manufacturers, 2500 heating contractors, 2500 builders, 2500 building contractors, 3500 oil heating dealers, 2000 oil jobbers and marketers, 1618 fire chiefs, 64 oil burning furnace manufacturers, 384 warm-air furnace manufacturers, 117 manufacturers of heating systems and boilers.

3. *An analysis of the degree of present acceptance of oil heat among home-owners of the country.* Actual interviews with several thousand home owners in different parts of the country are being obtained. To supplement these findings, questionnaires have been mailed to 5000 users of oil heat and to a similar number of non-users.

There is every indication that the survey will result in the presentation to the industry of a large amount of valuable information, never before available. The findings will be made available alike to the burner manufacturers and to the oil companies which are members of the Oil Heating Institute.

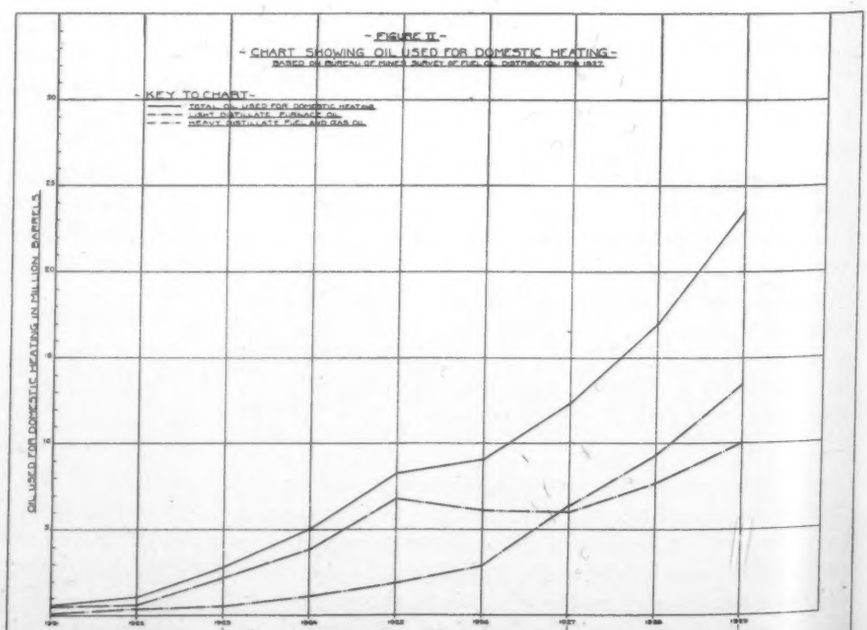
Now for the third point: "What can be done to further develop markets for fuel oil during 1929." First of all we should greatly increase our pressure on the market for domestic heating. To do this we must have the increasing moral and financial support of the oil industry and the burner industry. The indications are that we may count definitely on this for the coming year. Beyond that lies the very hopeful likelihood of expanding the commercial and industrial market for fuel oil.

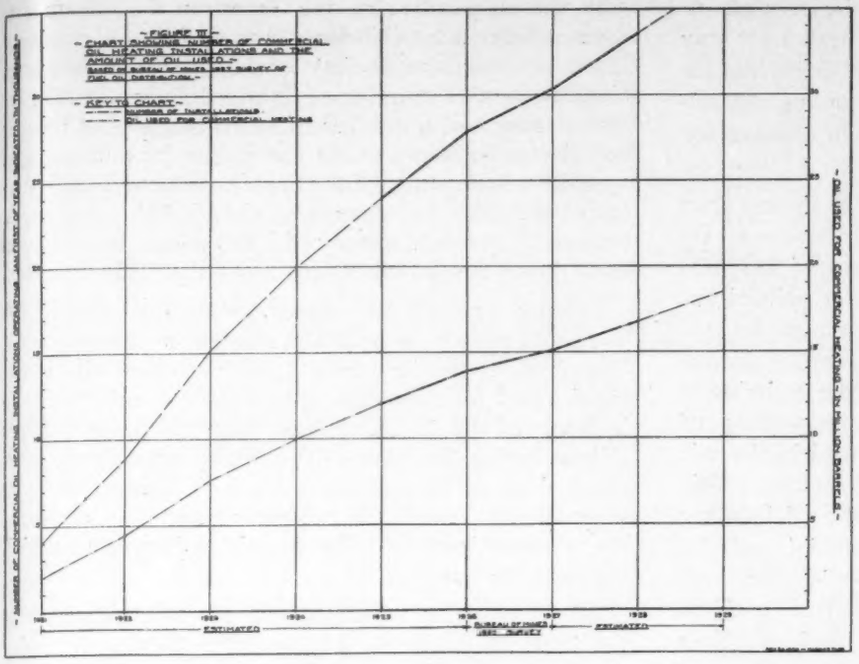
There is a vast potential market for crude and refinery residual oil used as fuel in commercial and industrial applications. The heating of large buildings probably offers the greatest opportunity, as in this field the inherent qualities that make oil a superior fuel are more readily appreciated.

As mentioned before, please remember that the term *"Commercial Oil Heating"* is used to classify the application of burners for heating of large apartments, office buildings, theaters, schools and similar buildings. This term should not be confused with *"Industrial Oil Burner,"* which is used to classify applications for developing steam for industrial power, and also the application of burners for industrial processes such as, heat treating, drying ovens, etc.

According to a survey made by "Building Age" and "National Builders," the 1928 building program called for the consruction of the following types of buildings for which oil is the most desirable fuel.

Building Type—	Total U. S.	In 294 Cities over 25,000 Population
Multi-family Apartments	26,520	14,200
Hotels	490	290
Public Garages	8,056	4,850
Office Buildings	2,915	1,600
Public Buildings	474	295
Factories and Workshops	8,070	4,920
Amusement Buildings, Theaters, etc.	1,545	955
Hospitals, Institutions, Schools and Libraries	5,625	1,230
Total	50,695	28,340


- FIGURE II -
- CHART SHOWING OIL USED FOR DOMESTIC HEATING -
BASED ON BUREAU OF MINES SURVEY OF FUEL OIL DISTRIBUTION FOR 1927
- KEY TO CHART -
TOTAL OIL USED FOR DOMESTIC HEATING
LIGHT DISTILLATE FURNACE OIL
HEAVY DISTILLATE FUEL AND GAS OIL
OIL USED FOR DOMESTIC HEATING IN MILLION BARRELS
ESTIMATED
BUREAU OF MINES SURVEY FOR 1927
ESTIMATED


- FIGURE III -
- CHART SHOWING NUMBER OF COMMERCIAL OIL HEATING INSTALLATIONS AND THE AMOUNT OF OIL USED -
BASED ON BUREAU OF MINES 1927 SURVEY OF FUEL OIL DISTRIBUTION -
- KEY TO CHART -
NUMBER OF INSTALLATIONS
OIL USED FOR COMMERCIAL HEATING
- NUMBER OF COMMERCIAL OIL HEATING INSTALLATIONS OPERATING AT END OF YEAR INDICATED IN THOUSANDS -
- OIL USED FOR COMMERCIAL HEATING IN MILLION BARRELS -
ESTIMATED
BUREAU OF MINES 1927 SURVEY
ESTIMATED

This gives a total of 50,695 new buildings of this type of which 28,340 are in 294 cities alone, representing a potential market for over 14,000,000 barrels which is almost as much as the total consumption for commercial heating during 1928.

Up to the present there has been no real attempt to develop this market and according to the most accurate figures we have available there are 33,550 commercial installations operating at this time, of which 3250 were installed during the current year. We believe that with an intelligently planned educational program, reaching influential groups such as architects, building contractort and operating personnel, the number of commercial heating installations can be increased rapidly, making this field a large and profitable outlet for the heavier fuel oils.

INDUSTRIAL OIL BURNING

There is scarcely an important industry that is not a potential user of oil for fuel in connection with process work requiring heat. Yet in this large field oil is not used in quantities proportional to its many advantages. This is due, undoubtedly, to the intensive and effective educational campaign made by gas companies. The large volume of gas used for industrial application is proof that there is a definite appreciation and willingness to pay for superior fuels.

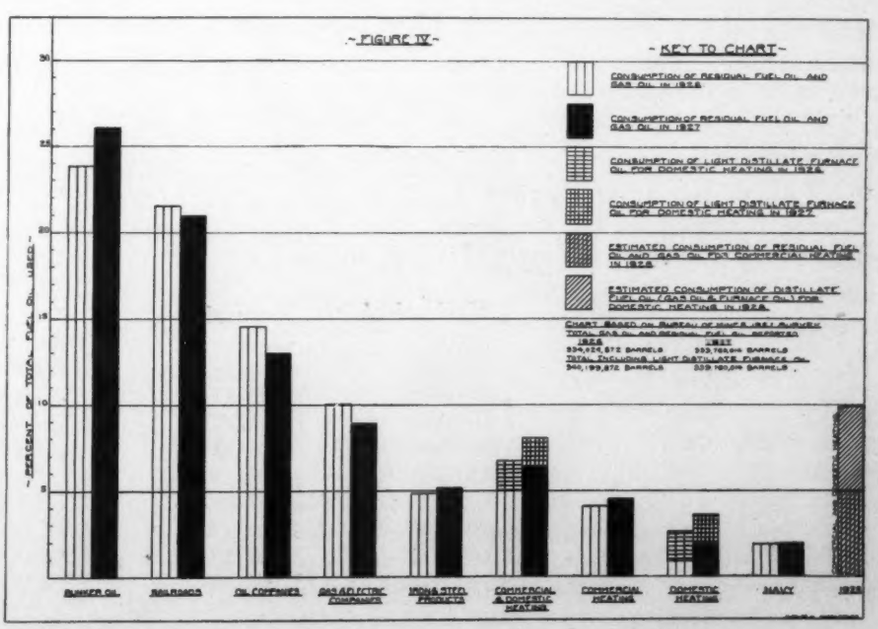
Oil possesses practically all of the superior features of gas and at the same time possesses a material price advantage. There is every reason to believe that the industrial field can, with carefully planned educational programs, be developed into a much larger market for both heavy and light fuel oil.

In the industrial field the possibilities of using heavy oil for high pressure power boilers is somewhat limited as the superior qualities of oil are not so readily considered and it therefore must compete with inferior fuels on a price basis. For industrial process work, however, the many advantages of oil are readily appreciated and demanded. At the present time considerable of this process work requires the use of the lighter oils, but we believe, that with the application of sound engineering principles many of these applications can be converted to the use of heavy residual oils.

Some of the more important industries that are ready for intensive development at this time are as follows: In the automotive industry there are a great number of heat treating, forging and oven-drying operations. In the cement industry oil is ideal for firing kilns. In the ceramic field productions from ovens can be greatly increased and improved products obtained. The glass industry offers a wide field for application to a number of applications ranging from the melting of the raw material to the annealing of the finished product. Working conditions in brass foundries are greatly improved and production materially increased by the use of oil. In the rubber industry and in paper and pulp mills the use of oil is ideal to meet the fluctuating demand from steam. The iron and steel industry already is a large user of oil and has many applications in heat treating and process work that can be well converted to oil.

The use of oil in all of the above industries is not the result of a well planned educational program but rather it is the result of self-education on th part of executives and operating personnel. As a consequence, this great industrial market offers a real opportunity for a thorough-going aggressive selling job.

In conclusion, I should like to point out the signifi-


- FIGURE IV -
- KEY TO CHART -
CONSUMPTION OF RESIDUAL FUEL OIL AND GAS OIL IN 1926
CONSUMPTION OF RESIDUAL FUEL OIL AND GAS OIL IN 1927
CONSUMPTION OF LIGHT DISTILLATE FURNACE OIL FOR DOMESTIC HEATING IN 1926
CONSUMPTION OF LIGHT DISTILLATE FURNACE OIL FOR DOMESTIC HEATING IN 1927
ESTIMATED CONSUMPTION OF RESIDUAL FUEL OIL AND GAS OIL FOR COMMERCIAL HEATING IN 1928
ESTIMATED CONSUMPTION OF DISTILLATE FUEL OIL (GAS OIL & FURNACE OIL) FOR DOMESTIC HEATING IN 1928
CHART BASED ON BUREAU OF MINES 1927 SURVEY
TOTAL GAS OIL AND RESIDUAL FUEL OIL REPORTED
1926 534,024,672 BARRELS
1927 533,760,464 BARRELS
TOTAL INCLUDING LIGHT DISTILLATE FURNACE OIL
540,193,872 BARRELS 539,760,464 BARRELS
- PERCENT OF TOTAL FUEL OIL USED -
BUNKER OIL
RAILROADS
OIL COMPANIES
GAS & ELECTRIC COMPANIES
IRON & STEEL PRODUCTS
COMMERCIAL & DOMESTIC HEATING
COMMERCIAL HEATING
DOMESTIC HEATING
NAVY
1928

cance of the point of view of two of the greatest industries in the United States toward oil heat. Last May the executive committee of the American Petroleum Institute formally went on record in endorsing the advertising and publicity program of the Oil Heating Institute.

Moreover, the executive committee went further than offering moral support but recommended that the oil industry support this program to the extent of $175,000 for the year 1928. This committee further pointed out that by reason of the fact that improvements in the fuel oil market being beneficial to all branches of the industry, it recommended that all units of the oil industry contribute to the funds referred to, regardless of whether or not they are at present engaged in the sale of oil for commercial and household heating. This whole-hearted support on the part of the oil industry has given the entire movement—commercial and domestic oil heating—an impetus that should go a long ways toward solving the vexing and intricate problem presented by our great oversupply of fuel oil. Now comes the second major American industry with a report, which will be made public this week, endorsing the idea of oil heating for commercial and domestic purposes.

I should like to quote a paragraph from a press release which will be given to the Associated Press this week; "The automatic heating of private homes and public and commercial buildings by oil burners electrically controlled is recommended as a new field for public utility companies in a report made public today by a committee of experts and electricity, oil and heating which has devoted the past eight months to a nation-wide study of this subject. The development of the electric refrigerator was preceded by a similar investigation more than a year ago. Comparing the oil burner with the refrigerator, the report says: "The total electric load per season per oil burner compares favorably with the refrigerator load and is deserving of being developed by public utilities."

The investigation was conducted by a special subcommittee of the National Electric Light Association with the cooperation of the American Petroleum Institute, American Oil Burner Association, Oil Heating Institute, American Society of Mechanical Engineers, Underwriters' Laboratories, National Fire Protection Association, and a number of individual oil, oil burner and electric light and power companies. Its purpose was to make a basic study of the modern automatic oil burner as the market for current for electric light and power stations. It involved a study of 700 separate installations in 17 key cities in every section of the United States.

Electric current, the report points out, cannot be stored. It must be used at the moment of manufacture. Power plants can be operated more economically when the demand for current is spread more evenly over the 24 hours of the day. The peak "load" of the oil burner comes during the hours of daylight when there is a sharp drop in the requirements for illumination. The seasonal peak comes in the winter and thus balances the seasonal peak of the electric refrigerator which comes in the summer.

The support of two such large industries speaks for itself. In addition, I wish to emphasize the point that the oil burner industry itself has now reached a place of stability as to product, and where, financially, it is out of its swaddling clothes.

While general public acceptance of oil heat might come in the course of time, neither the oil companies nor the burner companies can afford to wait. Already the gas companies are starting a drive to establish domestic gas heating plants. The coal companies are now putting on an organized drive not only for their product but against oil heat. The oil industry is faced with a vast overproduction of crude and with potential reserves which indicate that this problem may not be greatly mitigated for many years. And at the keystone of that superstructure, overproduction, is fuel oil, a vital factor in determining the value of your barrel of crude.

Fortunately the oil industry has recognized that in the domestic and commercial oil burner, it has at hand one of the most important instruments with which to successfully meet this situation. Moreover, that instrument is in keeping with a sound conservation program,

---

DOMESTIC OIL HEATING

TABLE 1-A

OIL CONSUMPTION BARRELS PER YEAR

Based on Bureau of Mines 1927 Survey Figures for 1923-1927
Average Consumption for Mechanical Draft Burners 60 Barrels per Year
Average Consumption for Natural Draft Burners 40

Year—	Mechanical Draft	Natural Draft	Total	Light Furnace Oil	Heavy Furnace or Gas Oil
1921-22	300,000	300,000	600,000	500,000	100,000
1922-23	540,000	500,000	1,040,000	640,000	400,000
1923-24	1,410,000	1,410 000	2,820,000	2,260,000	560,000
1924-25	2,840,000	2,180,000	5,020,000	3,855,000	1,165,000
1925-26	4,700,000	4,130,000	8,830,000	6,860,000	1,970,000
1926-27	6,820,000	2,260,000	9,080,000	6,170,000	2,910,000
1927-28	10,600,000	1,780,000	12,380,000	6,000,000	6,380,000
1928-29	14,380,000	2,620,000	17,000,000	7,650,000	9,350,000
1929-30	19,890,000	3,648,000	23,538,000	10,038,000	13,500,000

for such consumption of fuel oil and distillates comes under the classification of superior use.

The estimates, based on the United States Bureau of Mines figures, which I have given you, indicate that the market for domestic and commercial oil burners, and for their fuel, has hardly been scratched. With oil burners perfected, and with a more ready public acceptance of oil heat rapidly becoming a fact rather than a theory, it behooves the industries concerned to go after this vast market with the zeal of crusaders. If you consider only the facts as brought out by the Bureau of Mines Survey of Fuel oil consumption and the conservative interpretation that may be made therefrom, then to you who have vision and faith and energy, there can be no questions but that, "Beyond the Alps Lies Italy."

TABLE 1-B

Number of Burners Operating

Jan. 1, 1921	5,000	7,500	12,500
Jan 1, 1922	9,000	12,500	21,500
Jan. 1, 1923	23,500	35,300	58,800
Jan. 1, 1924	47,300	54,500	101,800
Jan. 1, 1925	78,500	103,000	181,800
Jan. 1. 1926	113,900	56,500	169,400
Jan. 1, 1927	177,000	44,500	221,500
Jan. 1, 1928	239,000	65,200	304,200
Jan. 1, 1929	331,500	91,200	422,700

TABLE 1-C

Net Gain or Loss

Year—	Mechanical Draft	Natural Draft	Total
1921-22	plus 4,000	plus 5,000	plus 9,000
1922-23	plus 14,500	plus 22,800	plus 37,300
1923-24	plus 23,800	plus 19,200	plus 43,000
1924-25	plus 31,200	plus 48,500	plus 79,700
1925-26	plus 35,400	minus 46,500	minus 11,100
1926-27	plus 63,100	minus 12,000	plus 51,100
1927-28	plus 62,500	plus 21,700	plus 84,200
1928-29	plus 92,500	plus 26,000	plus 118,500

TABLE II

Commercial Heating—Oil Consumption

Based on Bureau of Mines 1927 Survey for 1927 and 1927 Figures—Average Consumption for Commercial Installations 500 Barrels

Year	Total Fuel Oil	No. of Installations	Increase of Sales
1925-26	12,000,000	24,000	....
1926-27	13,875,000	27,800	3,800
1927-28	15,145,000	30,300	2,500
1928-29	16,750,000	33,550	3,250

TABLE III

Percentage of Total Fuel Oil Used

Rank—Use	1925	1926	1927	1928
1 Bunker Oil	20	23.8	26.2	28
2 Railroads	15	21.6	21.0	21
3 Oil Companies	10	14.6	13.0	13
4 Gas and Electric Power Plants	8.5	10.1	8.95	8
5 Iron and Steel Products	..	4.8	5.2	6
Navy	2	1.92	1.95	1.98
Commercial Heating	3.6	4.15	4.53	5.0
*Domestic Heating	.6	.87	1.91	2.77
Commercial and Domestic Heating	4.2	5.02	6.44	7.77

*Does not include Light Distillate Furnace Oil.

TABLE II-A

Percentage of Total Fuel Oil Used Including Light Distillate Furnace Oil

Use	1926	1927	1928
Commercial Heating	4.08	4.45	4.91
Domestic Heating	2.66	3.63	4.99
Commercial and domestic Heating Combined	6.74	8.08	9.90

Refinery Operations Reflect Efforts to Control Output

(*Continued from page 62*)

is really an economic waste to continue to run crude at the present rate.

At the present rate of gasoline recovery from crude, surplus stocks of crude represent about 132 million barrels of gasoline. By full utilization of the cracking process, they represent considerably more gasoline. Although the refining industry is considered apart from the producing industry, there is, nevertheless, an economic relation between them that must be given due consideration. On the other hand, however, the refining industry is in a better position to control its operations in conformity with the demand for its products. If we consider the combined situation, as it applies to refinery gasoline, we obtain the following picture:

GASOLINE SUPPLY SITUATION

	Million Barrels
Stocks of refinable crude on hand Jan. 1, 1928	372
Production, first 10 months	745
Imports, first 10 months	66
Total Crude Supply	1183
Proportion gasoline at 37.3 per cent. recovery	441
Gasoline stocks Jan. 1, 1928	32
Gasoline imports, first 10 months	4
Total visible gasoline supply	477
Gasoline consumption, first 10 months	319
Visible gasoline surplus	158
Actual refinery gasoline stocks Nov. 1, 1928	26
Available from crude storage	132

From the above, it is apparent that the petroleum industry is still suffering from the effects of overproduction. However, if the refining branch of the industry had given more consideration to controlling its operations, the market for petroleum products would undoubtedly have been more profitable. It is up to the refiner to give even more study to gasoline demand statistics and endeavor to gauge his still runs accordingly. Since many refiners are now cracking their surplus stocks of heavy oils, they should predetermine the effect of increased gasoline yields upon crude runs in relation to the normal demand. Practically all refiners and marketers are in a position to determine the market for their products, months in advance. By considering their stocks, market requirements and crude required, it is possible to maintain individual equilibrium. The results of the first 10 months of this year indicate that many are giving serious consideraton to these factors. Contnuation of such practice will not solve all of the ills of the petroleum industry, but will place the refining industry in a much healthier condition marketwise.

Towers In Series Fractionate Low Cold Test Lube Distillate

(*Continued from page* 59)

ter-inch turn of a one-inch valve. None is used in the scrubber drum, and the lubricating oil tower uses steam at the bottom at the same rate as the stripper tower. In the last, or naphtha tower, a small quantity of steam is used to assist in removing the ammonia injected into the bottom of the tower for the purpose of combatting corrosion.

TOWER PRESSURES

Tower pressures are of interest. With the tube still having an outlet pressure of 25 to 30 pounds the pressure is reduced before the hot oil enters the first of the fractionating columns. The stripper columns operate under a pressure of 14 to 15 pounds per square inch. In the second lubricating oil tower the pressure is lowered to about 12 pounds. The third, or naphtha tower, pressure is 10 to 11 pounds. Pressure gauges are provided at both top and bottom of all three towers. With a differential of but about one pound between top and bottom of each column it is indicated that very little resistance is offered to the vapors in their flow through the system of fractionators.

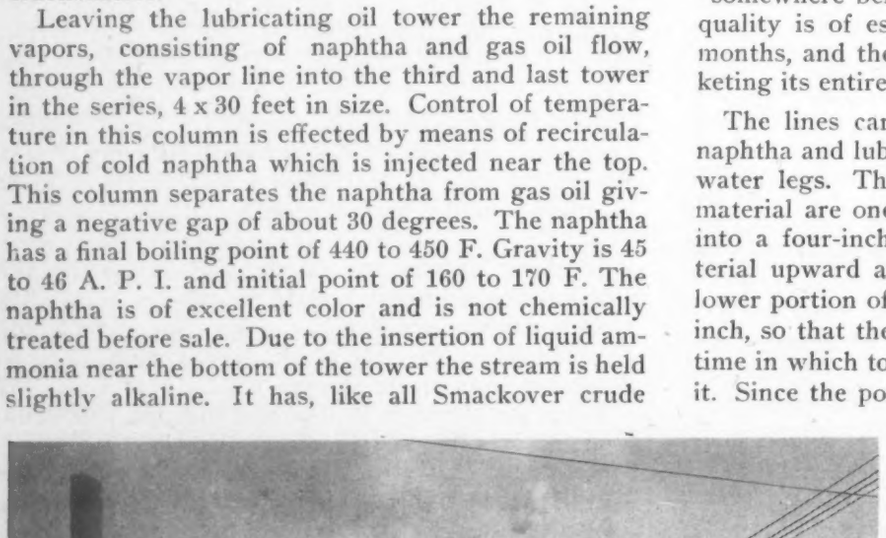
Leaving the lubricating oil tower the remaining vapors, consisting of naphtha and gas oil flow, through the vapor line into the third and last tower in the series, 4 x 30 feet in size. Control of temperature in this column is effected by means of recirculation of cold naphtha which is injected near the top. This column separates the naphtha from gas oil giving a negative gap of about 30 degrees. The naphtha has a final boiling point of 440 to 450 F. Gravity is 45 to 46 A. P. I. and initial point of 160 to 170 F. The naphtha is of excellent color and is not chemically treated before sale. Due to the insertion of liquid ammonia near the bottom of the tower the stream is held slightly alkaline. It has, like all Smackover crude gasoline, a high anti-knock value, averaging around 45 per cent. benzol equivalent.

Details of installation of automatic recording differential flow controller on crude oil charging line to tube still.

Gas oil, which accumulates at the bottom of the tower has an initial boiling point of about 480 F.—indicating the negative gap previously mentioned. The gravity is 26 to 27 A. P. I. and the flash point averages 230 to 240 F. This gas oil finds a brisk market as fuel for oil burners since the cold test is "somewhere below 50 degrees below zero F." This quality is of especial importance during the cooler months, and the company finds no difficulty in marketing its entire production.

The lines carrying reflux material over both the naphtha and lubricating oil towers are equipped with water legs. The lines from pumps handling reflux material are one-inch, and this small line discharges into a four-inch line which carries the recycle material upward and into the top of the towers. The lower portion of the four-inch line is enlarged to six-inch, so that the recycle media has a short length of time in which to settle free of any water carried with it. Since the point of entry is about four feet above ground, the water drops out into the section below this level. Gauge glasses are provided to indicate the level of water in the water leg, so that the operators can drain them of water whenever necessary. Details of the hook-up are shown in the close-up photograph of the tower from which side-streams of lubricating oil are taken.

From Smackover crude and with one heating the McMillan Company is securing a yield of 10 to 12 per cent. naphtha. Gas oil is recovered at 28 to 30 per cent. of crude charged. Lubricating oil distillate yields range from 10 to 12 per cent., with the remaining 50 to 52 per cent. withdrawn as asphalt flux and sold to the Berry asphalt plant on the same site.



James B. Berry and Sons' asphalt plant on the same site with McMillan refinery at El Dorado. Asphalt is air blown to proper specifications in this plant.

Employees Committees Make Safe Men

By W. GRAHAM COLE
Lecturer on Accident Prevention, New York University

Copyright, 1928, by the American Trade Press.

THE object of all the activities of managers and foremen in a safety campaign is to arouse the interest of the workmen to whom accidents may happen. The workmen's safety committee is an educational device which places upon the workmen themselves the responsibility for the prevention of accidents, and arouses their interest and enthusiasm as could be done in no other way.

Each foreman selects an assistant—if his department is large, two or three assistants—to represent him in safety matters. All of these representatives in the plant constitute the workmen's safety committee. Membership is not permanent since it is desirable to have as many workmen as possible bear, for a time, the responsibility of safety committeeman. The period of service varies, in different plants, from six months to a year. Six months seems to be the most suitable period since it allows sufficient time for definite accomplishment without being long enough to limit the work to a few men.

The selection of men for the committee is very important, especially when the work is being started. The first members of the committee should be men possessing the qualities of leadership, good workmen, respected by the others in their department, and capable of taking the initiative when necessary. Since one of the chief advantages of the cemmittee is that the members themselves become convinced of the value of safety, it is occasionally advisable, after the committee has been working successfully for some time, to select as members workmen who are not so convinced. Membership on the committee for six months will usually make them enthusiastic advocates of accident prevention. When this has failed, their conversion usually follows extension of their membership for another six-month period, though this is seldom necessary.

As a rule the members of the committee are permitted to select their own chairman and other officers, although in some plants, the superintendent or assistant superintendent acts as chairman. The minutes are kept by a member or a clerk from one of the offices who acts as secretary of the committee. Meetings are held, usually, once a month, though they may, if necessary, be held more often.

The primary responsibility resting upon a member of the committee is to spread the safety idea among the men in his department and encourage safe practices on their part. Together with the foreman, the safety committeeman will represent the company in safety matters, and will make the men feel that the foreman over them and all the officers of the company are staunch advocates of safety. He will carry to the men the ideas he has taken from the safety committee meetings, and do, in fact, everything in his power to make his department safe.

Another important duty of the member of a safety committee is to assist the foreman in inspecting his department, seeking conditions or practices which are likely to cause accidents, and helping remedy them. When some unsafe condition which should be called to the attention of the management is found, he should report it at the next meeting of the safety committee.

All suggestions which are made should be listed in the minutes of the meeting, and at the following meeting the men making the suggestions should be asked whether the conditions or practices complained of have been remedied. Suggestions which have been adopted and put into effect should be marked off the list, so that the men will know just what they are accomplishing. The minutes of meetings should be sent to the manager or superintendent, and to whomever else will have the power of carrying out suggestions. If for any reason the adoption of a suggestion is not feasible, an explanation should be made to the committee. The experience of many years of safety work has shown that 90 per cent. of all the suggestions made by workmen's safety committees are practical.

At the first meetings, the men usually hesitate to make suggestions, fearing censure. But when they find that their suggestions are being adopted, they talk more freely. An excellent example of this is seen in the safety committee of a railroad roundhouse, where accident problems are similar to those of most machine shops. At a meeting of the committee recently, each of the nine members rose and read a report of what he had done during the past month. Each man had at least 30 suggestions or comments to make. When the committee was organized, the men hesitated to speak, and few suggestions were made, most of them referring to unsafe plant conditions. Now, of the numerous suggestions, most refer to unsafe practices of workmen. This company was careful to follow up every suggestion made, or to convince the employes that suggestions were impracticable.

In addition to suggestions and reports on what has been done with the suggestions of the previous month, the program of meetings might profitably include a study of the accident records of the plant and the different departments, and the progress being made in the prevention of accidents. The workmen's committee offers an excellent place to start a friendly competition between the departments to see which can make the best safety record. The superintendent may be invited to address the members, and it is encouraging to the men to have a message from the general manager or president read at meetings. A speaker can occasionally be obtained from some other company to tell of the accident prevention experience in his plant.

The periodical change of the committee's personnel offers an opportunity for arousing interest in safety among the workmen. A meeting of retiring and incoming members, perhaps with the foreman present, can be held. A dinner may be given on this occasion, or there may be a meeting of all employes, at which the retiring members will be thanked for their services by an officer of the company, and the new members introduced.

Refineries Make Notable Progress in Economy in Fuel Consumption

REFINERIES of the country are making notable progress in the attainment of economy in the consumption of fuel required in their operations, according to the United States Bureau of Mines, Department of Commerce, which recently completed a survey covering the year 1927. This survey showed a decrease in the use of oil for fuel in 1927 of over 5,000,000 barrels as compared with 1926; a decrease in the use of coal of over 1,000,000 short tons; small increases in the use of both natural gas and refinery gas; and an increase in the use of petroleum coke.

The amount of fuel oil used at refineries in 1927 was 41,462,000 barrels. There was a decrease in fuel oil consumption of approximately 2,000,000 barrels each in the Atlantic Coast, Texas, and Louisiana-Arkansas districts, with an increase of 1,000,000 barrels in the Indiana-Illinois district, or a net decrease of 5,000,000 barrels. The decrease in fuel-oil consumption by refineries in the Texas and Louisiana-Arkansas areas was offset largely by increased consumption of natural gas and refinery gas, whereas the increased consumption in the Indiana-Illinois region was more than offset by the decrease in coal consumption.

The use of coal for fuel at oil refineries declined from 6,052,000 short tons in 1926 to 5,031,000 short ton in 1927. Practically all of this decrease was recorded in the Appalachian and Indiana-Illinois districts, which at the same time showed the largest percentage increase in the use of oil for fuel. It is probable, therefore, that although coal prices also fell off, a considerable quantity of oil replaced coal in this area in 1927. In addition, the group of refineries, which are by location more or less definitely committed to the use of coal for fuel, undoubtedly succeeded in saving a material amount of coal through the use of more efficient fueling methods.

A total of 130,815,000,000 cubic feet of natural gas was consumed for fuel at refineries in 1927. This represents an increase of eight per cent. over the 1926 total. Nearly all of this increase resulted from the opening of a line from the Monroe field to Baton Rouge, La. Had this line not been opened, there would have been a decrease in the use of natural gas, as a number of districts, particularly the Rocky Mountain, reported decreases in its use. The use of refinery or still gases for fuel did not change materially during 1927, there being a total of 52,807,000,000 cubic feet burned as compared with 52,077,000,000 cubic feet in 1926. Refinery gases are largely a product of cracking and it was probably more than a coincidence that a few districts in which cracking slowed down in 1927 also reported less refinery gas used as fuel.

Refinery engineers have recently given much attention to the problem of devising a thoroughly satisfactory method of burning the increasing production of pressure-still coke. That some progress was made in 1927 would seem to be indicated by the fact that consumption at refineries increased from 408,000 short tons in 1926 to 450,000 short tons in 1927, the latter figure being equivalent to 40 per cent. of the total output. Coke, particularly the type obtained by so-called dry distillation, makes a very superior fuel from point of heat units, but is one which requires constant mechanical supervision.

The problem of fuel economy continued to occupy the attention of many refinery engineers, and it was largely through their efforts that the fuel requirements in 1927 per barrel of crude refined were less than ever before. The total of all kinds of fuel used at oil refineries in 1927 is calculated by the Bureau of Mines as giving a toal of 584,000,000,000,000 British thermal units as compared with 630,000,000,000,000 British thermal units in 1926.

The Appalachian district again required a greater number of heat units per barrel of crude refined than any other district. The explanation of this fact undoubtedly lies in the large number of small refineries which were built in the days of "cheese-box" and shell stills before the present era of pipe-stills and heat exchangers; in the use for fuel of large quantities of coal, which ranks comparatively low in efficiency as used in the average Appalachian refinery; and to the fact that most of the crude processed in the Appalachian district is refined through the lubricant stage, and necessarily requires more fuel than simple skimming operations. The only district to report a higher fuel requirement per barrel in 1927 was the comparatively minor Louisiana Gulf Coast district. California and Inland Texas were the leading districts from the standpoint of low fuel requirements, due primarily to the fact that little of the crude refined in these districts was carried beyond the skimming stage, although it is suggested also that weather conditions might have been a factor.

A large part of the credit for the success attending fuel economy at oil refineries in 1927 may be attributed to the pipe-still. This type of equipment has been in general use for but a short time, hence its effects on fuel consumption were perhaps not widely felt prior to 1927. In combination with heat-exchangers, the pipe-still enables the refiner to double or triple his throughput, often without appreciably raising fuel requirements.

Further details are given in Serial 2886, by G. R. Hopkins, associate petroleum economist, copies of which may be obtained from the United States Bureau of Mines, Department of Commerce, Washington, D. C.

Institute Inaugurates Move to Form Refinery Technology Section

Three major branches of industry will have department under new plan; refinery representatives have more part in program at Chicago

THE American Petroleum Institute at its Ninth Annual meeting at Chicago under the leadership of its board of directors approved a plan of grouping its activities under three general divisions—producing, refining, and marketing.

Definite action at this time tending toward the organization of the three major groups extended only to the election of vice-presidents to head the activities of the departments. The work of reorganization of the ever increasing scope of Institute activities and the assignment of present group activities to their proper division will require some time. Under the new plan all matters affecting production will be grouped in the production division, marketing problems will fall into its division, and the manufacturing division will include all matters pertaining to the manufacture of petroleum products from crude oil and natural gas. Under this plan the executive committee of the board, through a subcommittee, will present a working plan for the permanent organization of the three divisions. The present activities of the Institute will be separated and incorporated in the work of their proper divisions.

This new "break-down" in the Institute operations will be conducive to the enlargement and expansion of Institute activities in matters pertaining to manufacturing problems, and should lead to the formation of a permanent Refinery Technology Section in this division.

The importance of the work of refinery technologists within the industry, is recognized by the Institute and positive indication of wide spread interest in the technology of manufacture is evidenced by the large attendance at the five group meetings of engineers and technologists. Meetings of this group were increased to five at this convention, whereas last year there were but two meetings given over to refinery technology. A total of 25 papers of great merit and importance were presented this year.

In addition to the group meetings covering refinery technology the work of other groups such as Automotive Transportation, a meeting on Corrosion, one on Marketing problems, another on Motor Fuels, and one on Oil Company Problems of Taxation, had a direct bearing on the manufacturing branch of the industry. The group meeting of refinery technologists which was given over entirely to the reading of papers and subsequent discussion of problems present having to do with pipe still distillation of lubricating oils proved to be highly informative and was probobly the best attended of the five sessions of this group, which indicates something of the interest which the industry has in the modern practice of tube still processing of lubricants.

The meeting of the Institute was officially opened at the first general session Tuesday afternoon. Axtel J. Byles, president of the Tidewater Associated Oil Company and vice-president of the Institute, presided in the absence of E. W. Clark, president, who was unable to attend the meeting. Mr. Byles' subject dealt with the rationalization of the oil industry. W. G. Skelly followed with a discussion of "The Value of Standardized Oil Field Equipment." The opening general session was concluded by the address of Craig B. Hazlewood, president of the American Bankers Association, "The Bankers Interest in the Petroleum Industry."

EDWIN B. REESER

E. W. Isom, Sinclair Refining Company, chairman of the committee on Refinery Technology, in reviewing developments in refinery technology before the group whose future activities will be incorporated in the work of the division of Manufacture, outlined the activities of the industry's technologists and compared the modern refinery with its scientific equipment with those plants of several years ago and cited the fact that much greater economy of operations and much higher efficiency of processing has been secured for the refining industry through the co-operative researches and experiments of this industry's ever increasing number of special-

ly trained technologists. The last year in refining industry history has been outstanding for the rapid development and utilization of modern distillation and fractionating equipment for both crude oil and cracking operations, by practically all refiners in order to meet present economic conditions in the industry. Refineries which are not equipped with efficient, low operating cost methods simply could not survive. It is the task of the division of manufacture to provide facilities whereby the technical workers in this division can exchange their experiences and findings to the end that still further economies may be effected and greater steps in perfection of still more efficient equipment may be taken, to the end that the manufacturing branch of the industry may take its proper place as a highly scientific industry.

REESER NAMED PRESIDENT

E. B. Reeser, president of the Barnsdall Corporation, Tulsa, was selected as president of the Institute to direct the organized effort of the industry during the coming year. J. Howard Pew, Sun Oil Company, Philadelphia, was elected vice-president representing Manufacturing. K. R. Kingsbury, Standard Oil of California, San Francisco, is vice-president representing Production. The vice-president representing distribution is Henry M. Dawes, Pure Oil Company, Chicago. The new office of executive vice-president was established with W. R. Boyd, Jr., serving in this capacity. Amos L. Beaty, New York, was re-elected treasurer and Lacy Walker of the Institute staff will serve in the capacity of secretary and assistant treasurer.

Members of the Executive Committee elected in addition to the president and the first three vice-presidents mentioned above, the treasurer and the last retired president, who are exofficio members, follow: Axtell J. Byles, president, Tide Water Associated Oil Company; R. W. Stewart, chairman, Standard Oil Company of Indiana; W. C. Teagle, president, Standard Oil Company of New Jersey; R. C. Holmes, president, The Texas Company; George S. Davison, president, Gulf Refining Company, and William N. Davis, vice-president, Phillips Petroleum Company.

The Membership Committee elected comprised the following: Roy B. Jones, chairman; L. P. St. Clair, P. M. Miskell, W. M. Irish, and E. T. Wilson.

American Petroleum Institute Directors Named

The Board of Councillors made the following nominations for directors of the Institute and those nominated were later elected at open meeting of members.

PACIFIC COAST (Production) GROUP

*L. P. St. Clair, Independent Oil Producers Agency, Los Angeles.
*D. S. Ewing, Ethel D. Company, San Francisco.
W. M. Storey, Standard Oil Company of California, San Francisco.

CENTRAL UNITED STATES (Production) GROUP

*W. S. Farish, Humble Oil & Refining Company, Houston.

EASTERN UNITED STATES (Production) GROUP

Axtell J. Byles, Tide Water Association Oil Company, New York.

PACIFIC COAST (Manufacturing) GROUP

*H. R. Gallagher, Shell Company of California, San Francisco.

CENTRAL UNITED STATES (Manufacturing) GROUP

*Roy B. Jones, Panhandle Production & Refining Company, Wichita Falls.

EASTERN UNITED STATES (Manufacturing) GROUP

*Edward Prizer, Vacuum Oil Company, New York.
*Frank B. Fretter, National Refining Company, Cleveland.
W. E. Smith, Standard Oil Company of Kentucky, Louisville.

PACIFIC COAST (Distribution) GROUP

*K. R. Kingsbury, Standard Oil Company of California, San Francisco.

CENTRAL UNITED STATES (Distribution) GROUP

*R. W. Stewart, Standard Oil Company of Indiana, Chicago.
L. L. Marcell, White Eagle Oil & Refinnig Company, Kansas City.

EASTERN UNITED STATES (Distribution) GROUP

*Amos L. Beaty, New York.

TRANSPORTATION GROUP

(Ships)

*J. Howard Pew, Sun Oil Company, Philadelphia.

(Pipe Lines)

*C. H. Kountz, Prairie Pipe Line Company, Independence.

SUPPLY GROUP

John S. Carroll, Johns Manville, Inc., New York.

FOREIGN TRADE GROUP

*W. C. Teagle, Standard Oil Company of New Jersey, New York.

AT-LARGE GROUP

*F. B. Henderson, Associated Oil Company, San Francisco.
*S. A. Guiberson, Jr., Guiberson Oil Investment Company, Los Angeles.
*W. G. Skelly, Skelly Oil Company, Tulsa.
D. J. Moran, Marland Oil Company, Ponca City.

At-Large Group was also increased by one and George P. Whaley, Vacuum Oil Company, was elected to fill this place.

THE DIRECTORS ELECTED THE FOLLOWING "DIRECTORS-AT-LARGE"

*E. R. Brown, Magnolia Petroleum Corporation, Dallas.
*H. M. Dawes, Pure Oil Company, Chicago.
Taylor Allderdice, National Tube Company, Pittsburgh.
J. C. Van Eck, Shell Union Oil Company, New York.
E. W. Marland, Ponca City, was elected to fill vacancy created by death of George H. Jones, Standard Oil Company of New Jersey.

---

*Re-elected.

Problems in the Desulfurization of Petroleum Products

By DR. A. E. DUNSTAN
Anglo-Persian Oil Company, London, England

MAY I first express my very great indebtedness to the American Petroleum Institute for giving me this chance for speaking tonight? It is an honor that I immensely appreciate, giving me as it does the chance of meeting so many fellow technologists.

Although the British representation here is very limited and is merely an advance guard, I do hope that we see the beginning of a large army that will come over each year to attend this annual convention.

I must apologize for not having had time to get this discussion printed for you. It was only a few weeks ago that Dr. Anderson asked me to come down here and it wasn't possible to get the paper together and have it printed in that short time.

I thought it might be appropriate this evening in connection with the problem of desulfurization merely to discuss the experience that we have had in Persia with a sulphurous crude and a natural gas containing upward of 14 per cent. of hydrogen sulphide. Those conditions are conditions that you are well familiar with on this side.

Taking the Persian crude oil in our main field, we have an oil of a paraffin base with about 1.5 per cent. of hard asphalt and with a sulphur concentration of a shade over one per cent. That oil is a perfectly sweet smelling oil.

The first point I want to draw your attention to is that the malodorous sulphur derivatives that appear in the distillates are in all probability decomposition compounds brought about by a decomposition of sulphur containing bodies in the crude. That is actually true because if you take the ordinary crude and distill it under ordinary conditions you get a gasoline containing 0.1 or 0.2 per cent of sulphur. If that same crude is gently flocculated with a small amount of acid and allowed to stand to precipitate the asphalt, and then is stilled, the same gasoline fraction would only contain about 0.025 of sulphur and would be reasonably sweet smelling.

THE FIRST GASOLINE

When the Anglo-Persian Oil Company decided 12 years ago to apply all its resources in chemical science to the problems of oil refining, we found that the accepted practice in the refinery was to wash the gasoline, the crude gasoline, with acid and soda and the result was that very little improvement was made in the smell. We had to investigate all of the known methods of achieving desulfurization.

In parenthesis I might perhaps say a word or two about the general problem of desulfurization. I suppose the first gasoline we had in Europe was of Pennsylvania origin with a gravity of about 68. It had a beautiful smell resembling that of petroleum ether. This, of course, spoiled the market for all time for other gasolines. Every subsequent gasoline had to bear comparison with that spirit. One often wonders if the first gasoline had arrived from Texas or Persia whether we should have saved a vast amount of time and money in tha researches we had to go through. After all, one must regard the desulfurization of gasoline from the point of view of practical politics. I am giving vent now to a heterodox statement: People like to have a spirit which they feel doesn't smell too bad. That is about all they are concerned about. The actual numerical content of sulphur is another matter that does not trouble them.

Provided your gasoline hasn't got any elemental sulphur, which is bad from every point of view, hasn't any hydrogen sulphide or evil smelling mercaptans, I do not see that the actual sulphur content is a thing to worry about. I say that particularly when you realize that in the Diesel and in the semi-Diesel engines it is quite customary to burn fuels containing upwards of three per cent, of sulphur content.

In approaching this problem of sulphur content in gasoline we first of all determined what sort of chemical sulphur compounds there were in the gasoline, and leaving out hydrogen sulphide we isolated a whole series of mercaptans and sulphides. Some disulphides were present and a trace, probably 0.01 of what might be called cyclic sulphur compounds.

In working out the refining scheme one naturally turns first of all to the removal of hydrogen sulphide. If you do not remove hydrogen sulphide at the earliest possible moment it will be air-oxidized into free sulphur and no reagent known will remove the free sulphur from the petroleum distillate. If you leave the free sulphur in the gasoline you are going to have trouble with corrosion all the way through.

SODA WASH EARLY

In actual practice we get our soda washing, or alkali washing done at a very early point, either in the condensor or immediately after condensation. That soda wash really serves two purposes. It removes hydrogen sulphide and to a certain extent it removes mercaptans. If the mercaptans are left in they also tend to oxidize into disulphides.

The removal then of acid bodies by alkali is of first importance. By using counter current treatment you can economize on soda and furthermore you can also

—and we are doing it at the moment—use ordinary lime water as a remover of these acid materials.

So then we proceed, having eliminate hydrogen sulphide, to remove the mercaptans. The lower the molecular weight of the mercaptans the easier the work of the caustic soda solution. Some mercaptans will only dissolve to the extent of about 30 per cent. in a soda wash that would remove the whole of methyl mercaptan and hydrogen sulphide. You get an equilibrium but you never get complete removal by that means. We had to turn to some other method of removing sulphide and the balance of the mercaptans.

Our early work was based on oxidation. We took up the idea of using hypochlorous acid which was an obvious line of attack. We also used bleaching powder but we soon found ourselves in trouble. The whole point of the hypochlorite treatment is this, that the salts hydrolize to form hypochlorous acid and that is the active agent. The more alkali you put in the more you drive the equilibrium to the side of the salt and reduce the concentration of the free hypochlorous acid, and the more you slow down the reaction the more specific the reaction becomes.

Let us take a few cases that can be illustrated. If you oxidize a mercaptan with hypochlorite then your main product is a disulphide. If you take, on the other hand, an alkyl sulphide, you get sulphones and with a disulphide you get acidic products. In some cases we have actually isolated a trace of ordinary free sulphuric acid. If that acid increases in concentration it neutralizes the alkali previously put in and you may get a rapid reaction setting in when free hypochlorous acid is produced.

I can show you that in the form of a curve. (Illustrating). This curve relates to the oxidation of an alkyl disulphide and if one puts on ordinate the chlorine used up and on the abscissa time, then with the strongly alkaline hydrochlorite the curve runs something like that, say with 10 per cent. of free caustic soda. If the concentration soda is 0.5 per cent. then the curve goes up so. If the concentration of the alkali is so small that sooner or later it is all used up by the acid produced in the oxidation, then the curve assumes this shape and suddenly goes up.

At this particular point you get neutralization of the alkali and then a sudden absorption of chlorine ending up with possibilities of chlorination.

HYDROCHLORITE PREPARATION

We make our hydrochlorite solutions now by passing chlorine from the tank cars into milk of lime and by a curious circumstance at a moment when you have the right amount of chlorine in the mixture the color changes from white to pink, a permanganate being formed and it gives the operators very excellent indication of the course of the reaction. This strong calcium hydrochlorite, 0.2 to 0.2½ normal in strength, is diluted to 0.3 normal and it has just about the right concentration of free alkali to prevent this sort of reaction going on.

After the operation the treated gasoline is merely washed with soda to remove traces of acid bodies produced and in point of fact to remove the very minor traces of chlorine compounds that are formed. By using a counter current treatment we get a sulphur content of an ordinary gasoline, of about 0.03 or 0.035 per cent. and a chlorine less than 0.01 per cent.

But, if by any chance the alkali concentration has been allowed to become too small, then you are in trouble with chlorination. The whole thing depends on the accurate concentration of the alkali.

By that means and using hydrochlorite to sweeten the mercaptans and to sweeten the lower odoriferous sulphides, the cost of a ton of gasoline treated from 0.1 sulphur, down to 0.035 sulphur, is about 3½ cents a barrel.

As a sweetening agent you have a substance there which is prepared easily, is easy to apply and has no messy residual to remove or to recover. All the Persian gasoline that we are making now is desulfurized or sweetened in this way.

There are cases, of course, where you want to get to a lower sulphur content than that. One important one is that of the white spirit used in dry cleaning. That is the middle fraction between gasoline and kerosene falling between 130 and 140 C and 200 C. Much of that white spirit is recovered by re-distillation.

If you have a sulphur content of more than 0.01 or by some evil chance you have left in your white spirit some free sulphur, you get a reaction on redistillation and a foul smelling spirit, which the dry cleaners refuse to accept. In such cases as that the first and foremost necessary thing is to remove every trace of hydrogen sulphide at the earliest moment, otherwise air oxidation takes place and there is free sulphur in the distillate.

TREATING KEROSENE

Passing on now to the kerosene. We had in the early days in our refinery a process derived from the Burma Oil Company. In the Burma refineries for many years past they have used for decolorizing wax, a heated, roasted bauxite, a local Indian mineral. They had found that by passing the melted wax through the heated oxide a very much better decarborization took place than by using various chars.

We started in Persia, in 1912 or thereabouts, using bauxite for decolorizing our kerosene.

We used a combination of the litharge and bauxite processes and prepared a merchantable kerosene. In the course of experiments dealing with the more efficient roasting of the bauxite and having had the advantage of reading David Day's earlier work on adsorption, and having followed the work that Gurwitsch did on the same subject, it occurred to us that possibly by getting the bauxite particles more effectively roasted and at different temperatures there might be the possibility of a specific adsorption of sulphur derivatives.

It turned out that, if the bauxite were roasted and used immediately before having had time to get in contact with moisture and adsorb various impurities on its active surface, you had a desulfurizing agent of very considerable efficiency. Careful experiments

Why Import *when we* Export

Here is a shipment of SMITH-Welded Oil Cracking Stills being loaded on board steamer, New York Harbor, for one of the 9 foreign countries to which we are now shipping.

700 Smithsteel Cracking Stills are in daily use in United States.

SMITH*WELDED*
CRACKING STILLS

A. O. SMITH CORPORATION, ***General Offices: Milwaukee, Wis.***

OIL AND GAS FIELD PRODUCTS DIVISION

District Offices at New York City, Pittsburgh, Tulsa, Houston, Los Angeles

Mention Where You Saw the Advertisement

indicated that first of all the bauxite reacted with the color in the kerosene and when the coloring matter had gone then it would again adsorb the various compounds in the kerosene.

We showed, for example, that by using very, very large proportions of bauxite as against kerosene, eight pounds to a gallon, almost 100 per cent. by weight, that we could bring a kerosene of sulphur content of 0.2 or 0.25 down to the order of 0.02 or 0.03. Up until almost the last year all our refineries have been desulfurizing and decolorizing our kerosene by filtration through specially roasted bauxite and used before it had cooled down and adsorbed material from the air.

During the course of that work in the refinery one or two curious anomalies turned up from time to time which were put down to mistakes in roasting, to using very sulphurous waste oil for heating the furnaces, and so on. Anyway, these anomalies turned out to be due to the presence of mercaptans slipping through the bauxite and resulting in a kerosene that was positive to the doctor.

We traced out a curious fact in this particular material. It turned out that if the bauxite, for example, is roasted in a current of carbon dioxide, after it has been thoroughly burned, or roasted in nitrogen, or hydrogen, it had not the faintest affect in adsorping mercaptans. But, if it is roasted right through in the presence of air and as pure air as possible, the mercaptans then disapper. That can only be legitimately accounted for on the supposition that the roasted bauxite does adsorb a certain amount of oxygen in the roasting operation, and the oxygen reacts with the mercaptan to form a disulphide, which is then adsorbed on the bauxite surface.

Up to a few months ago we used bauxite exclusively for kerosene. Only just now, this very moment, we have in operation in Persia, one of the largest Edeleanu plants, capable of processing over 1000 tons a day of kerosene and in the future all of our kerosene in Persia will be desulfurized by that process, removing sulphur compounds in the SO_2 layer and finishing refined oil with possibly four or five per cent. by weight of bauxite, just to give a final polish to the kerosene.

I would like here and now to say this that during the 12 or 13 years in which I have been able to experiment personally with the SO_2 method I have gotten more and more faith in the method as an entirely scientific method of removing objectionable material without the attendant losses that would be gotten in the ordinary chemical processes, more particularly with strong acid. In fact, I may almost say that my career as a technologist has been one long fight against sulphuric acid.

DIESEL FUEL

One passes from the kerosene side to some of the higher products. Let us take, first of all, the residue from skimming. In our case it is a 65 per cent. residue on the crude, and this material is a very ideal internal combustion fuel for heavy engines of the Diesel and semi-Diesel variety.

When I first had occasion to deal with this material as a Diesel fuel, we had a committee sitting in London, a Diesel engine committee, which had the business of formulating specifications for Diesel oils. Ten years ago the great bogey in Diesel oil was sulphur. If an oil contained more than 0.4 or 0.5 per cent .of sulphur it was damned forever as a Diesel oil. I suppose there are echoes of that damnation still about us. The evil, of course, lies in the sulphur dioxide produced in the combustion chambers and the corrosion thereby of the moving parts. However, after years of hard work the committee was convinced that much larger amounts of sulphur were innocuous and the bogey of sulphur disappeared.

That was then replaced for three more years by the bogey of asphalt. All trouble was ascribed to asphalt. If the hard asphalt went up to three, four or five per cent. inevitably you would wear out cylinder liners, trouble occurred and you wouldn't get complete combustion. That bogey disappeared and the current one is that the trouble in the Diesel oil is the dirt, the matter that people will not take the trouble to centrifuge out.

LUBRICANTS

The question of desulfurization of internal combustion fuels therefore does not arise in our particular case. Passing on, then, to the lubricating oil side, we must bear in mind that some anxiety has been caused in lubricating oil manufacture by the difficulty or impossibility, shall we say, of adequately desulfurizing the oil and yet maintaining it as a lubricant. It is perfectly easy to take a lubricating oil base and wash it with oleum and have a loss of 50 per cent. and get a water white material. The more you treat a lubricating oil the less lubricating quality you get. If you react on a lubricant with excessive acid, you certainly and definitely remove just those bodies which are so effective in maintaining the stable film that is essential for boundary lubrication.

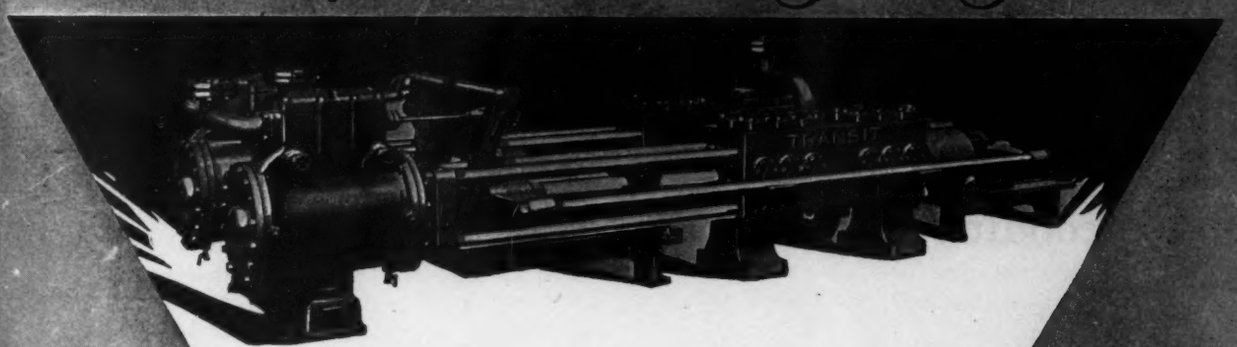
We had again, in our own oil, this problem that the lubricating oil fractions contained sulphur compounds. What is to be done about it? The more thoroughly those sulphur compounds were removed the less the oil lubricated.

In that connection, again, I would like to say that in all probability the removal of the more highly reactive components by physical means, rather than chemical, would probably be a fitting solution in the end.

I might say a word or two on the refining or desulfurizing of the various cracked spirits that one comes across in a refinery. Here again it is clear that the ordinary attack by acid not only produces heavy losses but also removes from the cracked spirit precisely those compounds you want there for anti-knocking properties.

(*Continued on page* 104)

TRANSIT
Hot Oil
PUMPS
Are in the spotlight, as the refiners favorite



NATIONAL TRANSIT
Pump & Machine Co.,
Oil City, Pa.

DISTRICT OFFICES
New York Philadelphia Cleveland
Pittsburgh Houston Tulsa Los Angeles

Have you considered the application of Vapor Phase Refining in your plant? The chances are that you too will find it possible to

Increase your gasoline yields,

Improve your gasoline quality, and

Cut your refining costs.

We will be glad to go over your own conditions with you and show you how.

THE GRAY PROCESSES CORPORATION

961-975 FRELINGHUYSEN AVENUE

NEWARK, NEW JERSEY

Application of the Pipe Still to Vacuum Distillation

By A. E. HARNESBERGER
Pure Oil Company

DURING the past few years a great amount of attention has been given to distillation processes that enable the oil refiner to obtain from crude oil the maximum yield of the various distillates and stocks at a minimum cost for labor, fuel and steam.

The pipe still at present is recognized as being one of the most economical distillation units and under proper conditions will produce oils of equal quality and yield as those produced by the less modern shell type still operating also at above atmospheric pressure. In either of the above mentioned types of equipment there is a limit to operating temperatures which would produce satisfactory heavy lubricating oil fractions by straight distillation.

The pipe still particularly, when operating at pressures above atmospheric cannot produce over head cuts of high viscosity unless oil outlet temperature is raised to a point above that at which partial cracking takes place resulting in a decreased yield of high viscosity fractions, these fractions having a poor color which results in expensive treating and filtering cost. Such high temperature operation generally results in decreased time on stream due to coke deposits in tubes and evaporator.

The advantages of batch stills operating under high vacuum are well known. They produce overhead products that are superior to those produced by the conventional shell still not using vacuum. However, since they employ fractional distillation the partial pressure effect of the lighter fractions is lost as the distillation proceeds resulting in higher distillation temperatures. In commercial sizes they also operate with a considerable hydrostatic head of fluid next to the heating surface which makes the vacuum less effective.

Therefore, the next development has been to apply the pipe heater to vacuum stills, using modified fractional condensing equipment designed to produce as many different viscosity cuts as wanted. It is well known, however, that pipe stills, utilizing the same cross sectional area for oil and vapor flow throughout the entire length of heating elements, operate at high pump pressures on the inlet side because of the very high frictional resistance set up by the volume of vapor generated as the outlet end of the still is reached. Even if a vacuum is carried on the outlet end it can not penetrate into the tube bank and be effective unless special provisions are made. As a result of this back pressure the heavier fractions of the oil are not vaporized unless excessive temperatures are maintained in order that sufficient heat of the liquid is available to supply the necessary latent heat of vaporization when the vacuum zone is reached. Some stills of this type have been designed with direct fired evaporators and other external sources of heat in order to make up the deficiency. However, in most cases of thins kind, the static head of the fluid in the heated chamber in part at least defeats the purpose and the operation reverts back to that of the shell type unit.

INCREASING AREA PRINCIPLE

In order to obtain the maximum possible benefit of vacuum distillation and to eliminate as many as possible of the objections referred to above a pipe heater was designed on the increasing area principle. The increase in area provides for the vapor volume as generated so that the frictional resistance of the flow can be reduced to point where a high vacuum carried on the outlet end of the still can penetrate far back into the heating element and thereby effect more complete vaporization in the tubes than obtained in other types of pipe heaters. This increase in area can be effected by increasing the number of parallel streams flowing through the heater using the same size tubes throughout or by using one stream and stepping up at intervals the size of the tubes. The latter method presents the least amount of construction and operating difficulties. In very large units the combination of parallel streams of

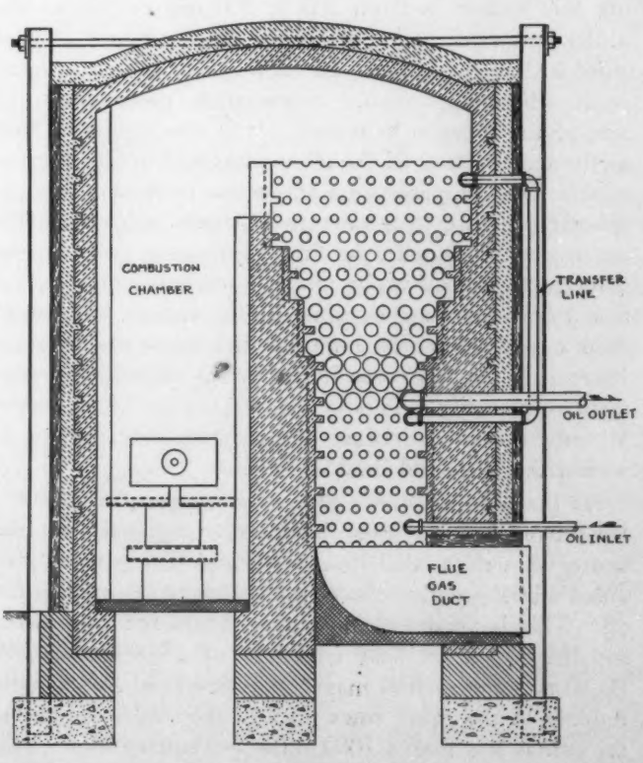


FIG. 1
VACUUM PIPE STILL

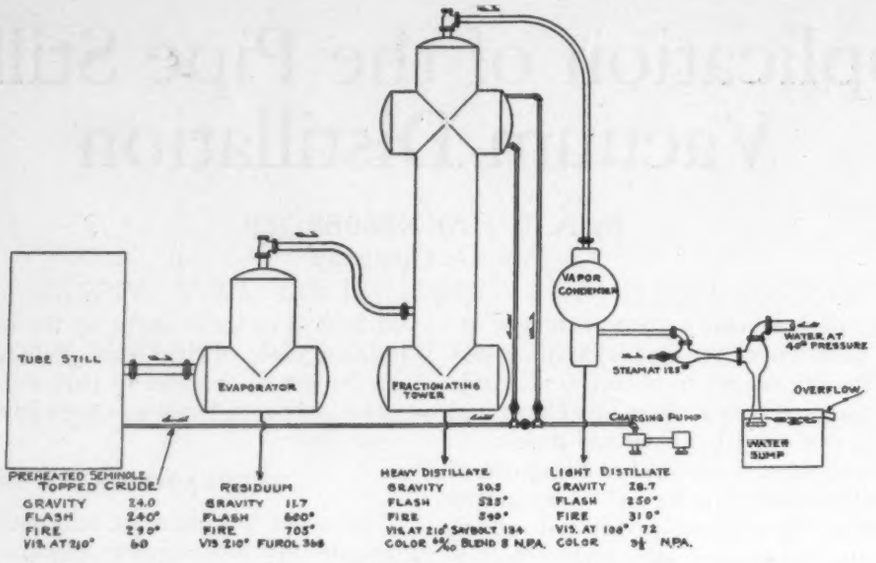


FIG. 2
FLOW DIAGRAM

increasing area becomes necessary in order to eliminate the use of too large tubes in the final passes of the still.

Figure 1 shows a cross sectional view of such a pipe heater. The tube bank is divided into two parts, a preheating and a final heating section. The preheater consists of a group of comparatively small tubes carrying the vacuum still charging stock at a fairly high velocity in a counter current direction to the flue gases. From the preheater the oil flows upward to the high temperature zone where the tubes are exposed to the full radiant heat of the furnace. Since the oil entering this section is from 200 to 300 degrees below the outlet temperature it can absorb the high rate of heat input without danger of local overheating. At a calculated point where appreciable vaporization takes place the size of the tubes is increased. It is also necessary that as the temperature of the oil reaches within 100 degrees of the final temperature a transition from above atmospheric pressure to a vacuum be made to assist in the vaporizing of the oil. As the vaporization proceeds the velocity of the oil-vapor mixture increases rapidly due to not only the space occupied by the vapors, but also to their expansion as the high vacuum zones are reached. Increasing the tube area by no means maintains a constant oil velocity. This is hardly possible or desirable. It only serves to reduce the frictional resistance to within the 14-pound limit allowable.

As the oil approaches the outlet temperature wanted local over heating must be guarded against. In the heater shown, parallel flow of oil and flue gases is provided which greatly reduces the chances of damaging the oil. This is apparent when it is considered that in the top row of tubes heat transfers of 15,000 to 20,000 B.t.u. per square foot may be expected but this rapidly reduces in the other rows until at the outlet the transfer rate is less than a 1000 B.t.u. per square foot. This low rate of heat transfer, together with a high liquid and vapor velocity on the inside of the tubes produces a uniformly heated mixture with freedom from cracking.

FRICTION REDUCED

The ratio of areas of the different sections of the vacuum tube bank depends upon the conditions to be met. The frictional resistance is a function of the length of travel, the type and number of return bends and the tube area. In turn these parts are determined by the number of square feet of heating surface desired. The latter is governed by the throughput, inlet and outlet temperature and per cent. vaporization of a given charging stock. Therefore, there can be no set rule to follow as to the relationship of cross sectional area of the vacuum tube bank.

The liquid vapor mixture leaving the heater at high velocity presents a difficult problem of separation. This problem is made more difficult by the fact that the separating and fractionating equipment must be as near frictionless to the flow of vapors as possible. This problem of separation and fractionation has been successfully worked out by our distillation department. Friction has been reduced to less than 2.5 mm. of mercury under maximum throughput and it may be practical to make an even further reduction. Figure 2 shows an outline sketch of the complete distillation unit and average results obtained on one type of charging stock.

The fraction from the bottom of the tower has cylinder stock specifications and after treating with five pounds of acid, contacting with 10 pounds of clay and dewaxing produced a bright stock of 7 N. P. A. color. That the fractionating tower gives good results is shown by the following method which was used as standard of fractionating efficiency. The tests of the first five per cent. over by laboratory vacuum distillation of the bottom of the tower were compared to those of the bottom five per cent. of the tower overhead. The flash fire and viscosity of the over head fraction were consistently the lowest. It is thought that this is a practical

means of determining lubricating oil fractionating efficiency.

COMPARISONS

Below is given a comparison of yields of lubricating oils from Seminole crude obtained by atmospheric shell still and vacuum pipe still distillation.

	Atmospheric Pressure	Vacuum
% 100 Viscosity neutral	1.25	2.68
% 200 Viscosity neutral	1.75	4.20
Total Neutral Yield	3.00	6.88
% Olive green stock	9.10	10.59
Flash	525	525
Fire	600	590
Viscosity at 210	150	134
Lb. acid per bbl. to treat olive green color	56	None
% Bright stock	4.75	7.15
Pour	25	30
Flash	530	530
Fire	600	595
Viscosity at 210	160	140
Color N.P.A. No.	7	7
Lb. acid per bbl. to treat from olive green	None	6
Filter yield from one ton No. 1 clay	17.0	39.1 bbl.

When distilling Pennsylvania crude a series of high flash and fire oils can be obtained as over head fractions having a lower viscosity than usual. For instance—an overhead product showing the following specifications was made representing a yield of 17.5 per cent. of the crude.

Flash (open cup)	480
Fire	545
Viscosity at 210°	69
Color 60/40 Blend	5
Gravity A.P.I.°	28.9

Percolation filtering of this oil showed a yield of 29.4 barrels per ton of No. 1 clay.

After removing the naphtha content the oil showed the following specifications:

Flash	500
Fire	560
Gravity	29.8
Vis. at 210	69
Color	4½ N.P.A.

This oil was further reduced in the pipe still under vacuum at 600 degrees outlet temperature into the following cuts:

Bottom of Evaporator:

Flash	560
Fire	625
Vis. at 210	92
Gravity	28.7
Color	5½ N.P.A.

Bottom of Towers:

Flash	450
Fire	520
Vis. at 210	50
Vis. at 100	220
Gravity	32.0
Color	4½ N.P.A.

Overhead of Towers:

Flash	385
Fire	450
Vis. at 100	142
Gravity	32.6
Color	2 N.P.A.

Proof that the distillation was not of a destructive nature is shown by the fact that when the above three fractions were blended back on the basis of the same per cent. that they were produced, the blend showed the following specifications:

Flash	490
Fire	555
Vis. at 210	68
Gravity	29.8
Color	4½ N.P.A.

It is to be noted that the original charge and the blend have practically the same viscosity and color showing that the distillation was not of a destructive nature.

The still is also well adapted to reduce dewaxed long residuum to brightstock taking overhead finished neutrals the viscosity of which can be controlled by the tower operation. Pressed oil also can be reduced to a viscous bottom with very good results.

The amount of vacuum to carry is a subject for further study. The hydro-steam jet vacuum pump used produces 6 mm. absolute. The work has been carried on at a widely varying range of vacuum with and without steam. Lowering the vacuum from 6 mm. to 30 mm. absolute by the introduction of small amounts of highly superheated steam into the evaporator maintains the same gravity bottoms at the same furnace outlet temperature and by decreasing the vapor velocity results in a slight increase in fractionating efficiency.

The various cuts having viscosity below 100 sec. Saybolt at 210 degrees can be removed by either direct acting steam pumps or centrifugal pumps provided with recirculating and priming connections. At least a four foot static head on suction is needed.

Fractions above this viscosity were handled with vacuum traps and rondown tanks carried at a vacuum of 60 mm. absolute by means of a single stage steam jet. Static head serves to overcome the difference in vacuum between the run down tanks and still.

As refining units, vacuum stills are undoubtedly going to become more popular with refiners. Especially pipe still units should have a wide application since operating as they do on a continuous basis maximum efficiency and low maintenance results. In their present stage no great amount of difficulty attends their operation. Improvements in their mechanical design coupled with the efficiency of welding makes it possible to carry high vacuum with low cost for vacuum producing equipment and its operation.

Refining of Gasoline Distillates From West Texas Crudes

By H. H. HEWETSON
Beacon Oil Company

DURING the past few years Texas has opened up an area of production in the western part of the state which will prove of great importance to the oil industry for years to come. In 1923 a very promising area was discovered in Reagan County, and in 1926 and 1927 flush fields of almost unlimited capabilities were opened up in Pecos, Crane, Upton, and Winkler Counties. The prolific yield obtained from these fields in the Permian Basin area has greatly stimulated exploration; in an area of some fifty thousand square miles there can at present be no estimate of the amount of oil which will ultimately be recovered. It is certain, however, that West Texas, with the extension of this producing area into Southeastern New Mexico, will prove to be one of the most prolific oil fields in the world.

The first few shipments of crude from the Permian Basin area established the fact that these crudes differed to a marked degree from other Texas crudes. Further investigation showed that in order to process these crudes satisfactorily new methods would need to be developed to overcome the two great difficulties which were encountered — corrosion of pipe lines, storage tanks, and refinery equipment, and sulphur content of the gasoline (and to a lesser extent other overhead products) above the prescribed limits.

When it became evident that these fields were capable of a daily production of hundreds of thousands of barrels of high-gasoline crude, the importance of overcoming these two difficulties with West Texas crudes became most apparent. So today there is a definite production in these fields, a definite demand for the crude on the part of the refiners, and a definite set of problems to be solved, both by the producers and the refiners in handling and processing these crudes with the greatest efficiency and lowest ultimate cost. Extensive study has been given to the problem of overcoming the corrosive action of these crudes; the difficulties of refining these crudes have not been as generally discussed. It is with this latter problem that the present paper is chiefly concerned.

The following crudes are in general representative of the production from West Texas fields:

Field—	Gravity	Sulphur	Gasoline Content	S in 410° E. P. Gasoline without treatment
Crane-Upton	28° API	2%	20%	.16%
Winkler	29° API	1.5 -1.75%	20-25%	.20-23%
Pecos	30° API	1.25-1.75%	20-25%	.18-20%

It will be noted that these crudes have, in general, some what similar properties. The gravities range form 28-30° API, with a gasoline content of 20-25 per cent; the sulphur in the crude ranges from 1.25-2 per cent, and the sulphur in straight-run gasoline of 410° E. P. contains 0.16 per cent to 0.23 per cent sulphur before treatment.

When we distill these crudes on a laboratory scale to 600 degress F. vapor temperature and absorb with caustic soda the non-condensable gases which are given off, we find that between 1 and 2 g. of hydrogen sulphide is evolved by each liter of the crude. This content of hydrogen sulphide is quite high, and shows that the crude carries considerable hydrogen sulphide gas in solution. When these crudes are topped, deposits of free sulphur are formed in the condenser tubes showing that elemental sulphur is also dissolved in the crude oil. The overhead fractions from topping are unusually high in sulphur and extremely difficult to sweeten, which indicates that the crude contains considerable amounts of organic sulphur-containing compounds such as mercaptans, thioethers, disulphides, etc. Every crude contains sulphur to some extent and in some one of the three forms mentioned, but apparently in West Texas crude we have the undesirable case of all three forms of sulphur and sulphur compounds present in considerable amounts in the same crude.

TREATING REQUIRED

Various types of operation, depending in large measure on the types of equipment available, have been used in the refineries which are operating on West Texas crudes. If the crude is topped to give a well fractioned straight-run gasoline of good end-point, a sulphur content before treatment of 0.16 per cent. to 0.25 per cent. may be expected. When acid is treated and sweetened with sodium plumbite without rerunning, the finished gasoline will have a sulphur content between 0.10 per cent. and 0.15 per cent., though the gum content will be somewhat high. If instead this acid treated stock is rerun with the addition of gas oil or sweet crude bottoms, the finished gasoline will be below 0.10 per cent. sulphur with a good gum test. Frequently a distillate is produced containing 80-90 per cent. of E. P. gasoline; this distillate will require 10-15 lbs. of 66 degree acid, and when rerun and sweetened will give a gasoline having below 0.10 per cent. sulphur and a fair gum content.

The residue from such a topping operation may be further reduced, giving an intermediate cut which is used as charging stock for cracking stills, or the topped residue may be cracked directly. The treatment of the cracked gasoline produced by either method to meet sulphur specifications presents a much more difficult refining problem than does the straight-run gasoline. Probably the simplest way to overcome the sulphur problem in West Texas cracked gasolines is to run in addition enough sweet crude to give a blended gasoline which will meet specifications. By this procedure, however, the price advantage of West Texas crudes over sweeter crudes is to some extent

sacrificed, and in some refineries the necessary amount of sweet crudes is not available at any reasonable price. As another possibility, the distillate may be double acid treated and double rerun. Such a procedure may be considered as the refiner's last resort; it has never failed on other crudes and has not failed on West Texas crude, but is so much more expensive than single treatment that it may be more profitable to shift to other crudes than to trefine West Texas crudes by this method.

PRESENT EXPERIMENTS

At this point I wish to state that at the time of accepting the opportunity to speak before this convention, it had been my hope to inform you of some more suitable means of removing sulphur from West Texas distillates. Our staff has been working very diligently on this problem, but as yet we have arrived at no results that can be applied as practicable refinery methods. In such an active problem—one which is generally, I believe, unsolved—I feel that it is worth while to present at this time a summary of the scope of our investigations, which though undeniably lacking in finality may yet lead to new channels of endeavor and serve to stimulate greater activity in solving a problem which is one of the most important now confronting the industry.

It is not my purpose at this time to call to your attention the tremendous sums expended yearly for chemicals to meet the requirements of a specification, nor to dwell on the economic losses due to the action of these chemicals, nor yet to comment on the quality of the gasoline which would be produced if the use of these chemicals were reduced or discontinued entirely. Our efforts have been concentrated on finding a cheaper and more satisfactory means of reducing sulphur in the distillates from West Texas crudes so that these distillates may meet existing specifications.

In approaching such a problem we must differentiate between the viewpoint of the research chemist and that of the refinery manager. In the laboratory it is possible to treat a crude distillate by any one of a considerable number of processes and obtain as a finished product a gasoline containing less than 0.10 per cent. sulphur. The correct procedure on the part of the chemist who attacks a problem such as we are considering is first to find out as many methods as possible of attaining the end which he seeks, and only then to give consideration to the factor which is of chief interest to the refinery manager—the production of a desirable product at an economically profitable cost. As a specific instance, it has been found that by treating crude cracked distillate of about 0.3 per cent, sulphur content with a saturated aqueous solution of mercuric acetate and then with a little acid, a gasoline will be produced on rerunning which requires a very doctor for sweetening and which is well under 0.1 per cent sulphur. This method is altogether satisfactory in the laboratory, but because of the cost of the chemicals involved is obviously out of the question as a practical refining method. Our research staff has tried out literally hundreds of treating methods; some, like the one mentioned above, have indicated processes which were theoretically effective but practically out of consideration. It is my hope, however, that some of the other procedures that I will outline may lead to results, either in our laboratories or in the hands of other workers, which will be both effective and profitable in the refinery.

SULPHURIC ACID TREATMENT

The customary treatment of crude cracked distillates with sulphuric acid is largely for the purpose of reducing the sulphur content of the distillate. There can be no question that sulphuric acid has this effect but the use of this treatment costs money for the acid, brings about a shrinkage in the volume of the distillate and accordingly in the volume of saleable gasoline, removes from the distillate constituents of great value for anti-knock purposes, and (when an excess of acid is used) may result in serious corrosion of rerun stills, condensers, and tankage.

There are at least four variables involved in acid treatment: strength of acid, quantity of acid, temperature at which the treatment is carried out, and time of exposure of the distillate to acid. The grades of acid generally available are 60 degree, 66 degree, 98 per cent., and 20 per cent. oleum, Our experiments have indicated that acid as dilute as 60 degree is too weak for ordinary refinery use on distillates from West Texas crude; acid of gravities between 60 degree and 66 degrees freezes at temperatures so high (up to 46 degrees F.) that these strengths are not suitable for cold climates, so that 66 degree acid is the lowest customary grade. Acid stronger than 98 per cent. will not reduce the sulphur content of the finished gasoline below a point attainable with larger quantities of 66 degree or 98 per cent. acid, and extracts an unduly large proportion of desirable constituents, as well as having a tendency to give a gasoline unstable to light and of high gum content. There can be no doubt that 98 per cent acid is a more effective treating agent than 66 degree acid, but the stronger grade leaves in the treated distillate, even after a caustic wash, compounds (probably alkyl sulphates) which evolve free acid on rerunning, and thereby bring about very serious corrosion of rerun stills, condensers and coolers, rundown lines, etc.

The *quantity* of acid used should be regulated by the amount of sulphur which must be removed from the distillate. The use of a large quantity of acid will reduce the amount of sulphur in the distillate very greatly; e.g., treatment of a crude cracked distillate containing 0.38 per cent. of sulphur with thirty pounds of 66 degree acid per barrel, followed by rerunning, reduced the sulphur to 0.03 per cent. in the unsweetened gasoline. The use of a large quantity of acid, however, increases the treating costs, increases the loss on treating, and may introduce serious difficulties in handling the fresh and the spent acid.

The *temperature* at which treatment is carried out markedly affects the intensity of the action of the acid on the constituents of the distillate. Sulphuric acid as a treating agent may act in either of two ways: as a solvent or as a polymerizing agent. From its chemical structure,

$$O=S(-OH)_2$$

, sulphuric acid (like liquid sulphur dioxide) might be expected to exert a particular solvent action on the organic sulphur compounds which are to be removed from crude distillate. If the treatment is carried out at temperatures well below 32 degrees, this solvent action may take place almost without resinification of the unsaturated hydrocarbons which are so desirable as anti-knock constituents of gasoline. A paper read about a year ago by Mr. R. A.

Halloran of the Standard Oil Company of California (Proceedings, 1927, Annual Meeting, p. 153) describes the use which his company has made of this principle. At the usual treating temperatures, the action of the acid is primarily to resinify ustable compounds and remove them as sludge. This involves shrinkage in volume which may roughly correspond to the volume of fresh acid used, but with the disadvantage of the heavy economic loss thus caused (which may exceed $50,000,000 a year in the United States) there is nevertheless the beneficial effect of removing the undesirable sulphur compounds. In general it may be said that if the temperature of treatment is increased, the amount of acid of a given strength may be decreased or the same amount of weaker acid used to give an equal treating effect, or a more intense treating effect attained with other conditions held constant.

TIME ELEMENT

Careful regulation of the *time* of the treatment is important for several reasons. The ability of the sulphuric acid to resinify desirable compounds continues after the sulphur-removing power of the acid has been exhausted. To avoid excessive treating losses, the distillate should be exposed to action of the acid no longer than is necessary to reduce the sulphur to the desired point. We have found that when treating West Texas distillates, the settling time after acid treatment should also be reduced as much as possible; if the distillate is left in contact with the acid for an hour or more, some secondary reaction takes place (probably the formation of alkyl sulphuric acids) which increases the amount of sulphur in the distillate.

The use of continuous treating towers rather than batch agitation of the distillate and acid by air blowing is a very desirable change in the last decade. As a general principle, a continuous process, whether distilling or acid treating, is more economical of time and materials and more readily controlled than a batch process. The loss of light ends by air blowing, while relatively small, is in the aggregate considerable. More important than this, however, is the fact that acid in the presence of air (as in air-blown batch treatment) removes much more of the desirable antiknock constituents than does continuous treatment, with no corresponding advantage in sulphur reduction.

A preliminary treatment with doctor or hypochlorite tends to reduce the amount of sulphur in the treated distillate, but the same result may be attained at less expense by using more acid. The same is true as regards a treatment with doctor or hypochlorite before rerunning. One would think that a preliminary wash of the crude cracked distillate with caustic would tend to reduce sulphur in the treated distillate by removing any hydrogen sulphide which might be present in the distillate, but our experiments with this form of treatment on West Texas stocks have given conflicting results indicating that the method is at best of limited value.

If after acid treatment, the treated distillate is neutralized with clay instead of with water or caustic, the sulphur content of the treated distillate is reduced, but the gasoline obtained on rerunning is not improved. For example, a crude cracked distillate containing 0.28 per cent. sulphur before treatment showed 0.26 per cent. after treatment when neutralized with caustic and only 0.15-0.18 per cent. when neutralized with clay. In both cases, however, the gasoline obtained on rerunning these distillates contained 0.12 per cent. sulphur.

I do not need to mention the important problems involved in handling and recovering the chemicals used in treating crude distillates. Within the past few years a number of methods have been developed which enable the refiner to reduce his expenditure for litharge by 60 per cent. to 80 per cent. Notable among these are the method involving reoxidization of lead sulphide to sodium plumbite by blowing with air, and the method of the Litharge Recovery Corporation in which the lead sulphide is converted to lead sulphate by treatment with sulphuric acid, and the lead sulphate then dissolved in caustic to form doctor solution. At our refinery the latter process has been used very successfully for a number of years. Sludge acid, like the poor, we have always with us. The disposal of this product is a very real problem in almost every refinery, and acid recovery processes are valuable rather as a means of removing an undesirable waste product than as a means of appreciably reducing refinery expenses.

TREATMENT WITH OTHER ACIDS

Sulphuric acid is by so great a margin the cheapest acid available to the manufacturer and the refiner that experiments with other acids were undertaken more as a possible aid in developing treating processes of economic value than as possible treating agents in themselves. It was found that glacial acetic acid as a treating agent was wholly inactive—the acid completely dissolved in the crude distillate, and readily washed out, leaving the distillate apparently unchanged. Syrupy phosphoric acid also appeared entirely inert. Concentrated nitric acid apparently oxidizes and nitrates certain compounds in the distillate; the concetrated halogen acids—hydrochloric, hydrobromic, and hydrofluoric—seem to form halides or addition compounds with the unsaturated constituents of the distillate. In every case the finished gasoline obtained by rerunning these acid-treated samples showed residual acidity, high gum content, and instability to light. It was not possible to determine the sulphur in these gasolines by the usual Robinson method, for the reason that the compounds in the gasoline which caused residual acidity seemed also to show up as free acid in the combustion gases, thereby preventing the determination of sulphur as sulphurous or sulphuric acids.

HYPOCHLORITE TREATMENT

Sodium hypochlorite as a sweetening agent is well known and widely used, but this reagent does not seem to have any appreciable effect on the sulphur content of West Texas gasoline except as it avoids the danger incident to the use of doctor solution of adding an excess of sulphur to break out lead mercaptide in the form of lead sulphide. The use of an excess of hypochlorite or of hypochlorite in too concentrated solutions seems to bring about chlorination of some of the compounds present in crude distillate and thereby gives rise to residual acidity, high gum content, and instability to light. As I have already mentioned, the use of hypochlorite before acid

(Continued on page 99)

Reducing 2500 Barrels a Day Pennsylvania Crude To Cylinder Stock Bottoms on Single Pipe Still

By A. C. VOBACH
Sinclair Refining Company

THE comparatively recent general adoption of the pipe still unit for handling various distillation problems of the oil industry has given the Eastern refiner an opportunity to adapt this type of equipment to the distillation of paraffin base crude in the production of lubricating stock.

It is true that on Mid-Continent oils and asphaltic base crudes pipe still development has been carried the furthest, but in both of these applications with the present over-abundant crude supply the desirability of running with minimum cracking action has not been so urgent.

On Pennsylvania crude, where the bottoms product must meet strict specifications in regard to tar content, and where the original cost of the crude is so high that the refiner must secure the maximum possible amount of viscous lubricating oil in order to get the greatest value out of the product, it is very essential that the refining operation be conducted without cracking.

This was formerly more or less successfully accomplished on the old batch shell stills at the expense of rerun of most of the overhead cuts, which were usually poorly fractionated, and by the aid of one hundred or more pounds of steam per barrel of crude run.

With the application of the pipe still and coincident development of efficient fractionating towers it has been found possible to take a gasoline, combined kerosene and fuel oil, paraffin distillate, and cylinder stock, from a single tower at the outlet of a pipe still; each stock well fractionated and with the utilization of less than 25 pounds of steam per barrel of crude processed, and decreased fuel consumption.

Further, for a given required production the pipe still unit is materially cheaper than either continuous or batch shell type stills.

Material made on pipe still operations lends itself readily to further treatment since it has been exposed to heat for only a very short period and the velocity while heat is applied is so great that good heat distribution takes place and superheating of the oil film next the heating surface does not occur.

It is the purpose of this paper to give a description of the construction and operation of 2500 bbls. per day unit making the above cuts, and to bring out for discussion such points as will aid in the development of this type of still to an even higher state of perfection.

EQUIPMENT

The oil heater is of well-known manufacture and has outside dimensions 22 feet 6 inches long by two feet wide by 26 feet high above foundation. Furnace is 12 feet by 18 feet by 22 feet 6 inches high with an air cooled bridge-wall three feet thick by 18 feet high.

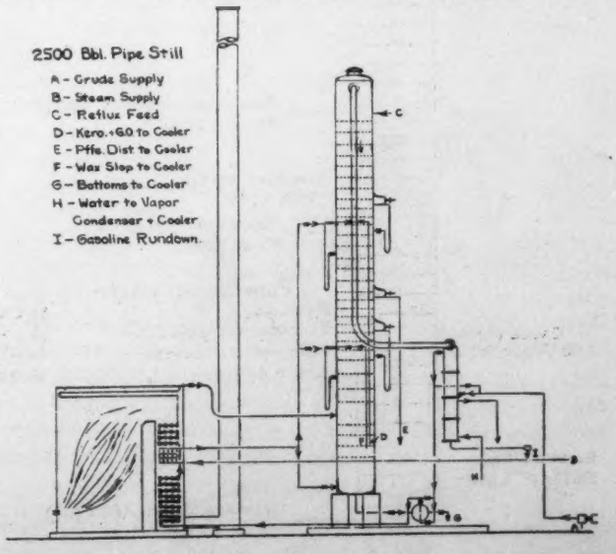
Running longitudinally below the roof are 56 four-inch six-gauge bare radiant heat tubes, each 18 feet long in the heating zone. Behind the bridge-wall in the convection bank are two sets of tubes. The lower contains 36 four-inch six-gauge tubes covered with four-inch by 6⅝ inch ringed castings for heat absorption. These are arranged in nine vertical rows, four tubes to the row, with an effective length of 18 feet per tube. The upper set of tubes contains 16, with four rows of four each, same length as the others. The two upper rows are covered with four-inch by 5½-inch corrugated rings, the two lower having finned rings similar to the lower 36 tubes.

Between the two sets of convection tubes is the steam superheater, consisting of 20 two-inch nine-gauge tubes 18 feet long, covered with two-inch by 4⅝-inch rings. All tubes have ¾-inch cores and each five tubes in a row are in parallel, with headers at the ends.

The crude flow enters the lower bank of 36 tubes, passes through an outside line around the superheater into the upper 16 convection tubes, then into the lower row of roof tubes and finally through the upper 28 roof tubes into the fractionating tower.

Total length of oil heater is roughly 2050 feet, including return bends, and the oil remains in the heater a maximum of 15 minutes if no vaporization in the heater is assumed. With partial vaporization as undoubtedly occurs in this heater, we can safely say that the oil is under temperature probably eight to 10 minutes or less, and reaches a velocity at the point of greatest heat application of possibly 250 feet per second.

Instrument board mounted on side of heater shows temperature of furnace gas above convection bank on right and left sides, temperature of flue gas leaving tubes, CO_2 in waste gas, drafts, pressure of oil


2500 Bbl. Pipe Still
A – Crude Supply
B – Steam Supply
C – Reflux Feed
D – Kero.+GO to Cooler
E – Pffe. Dist to Cooler
F – Wax Slop to Cooler
G – Bottoms to Cooler
H – Water to Vapor Condenser + Cooler
I – Gasoline Rundown

into and out of heater, and temperature of oil into and out of heater.

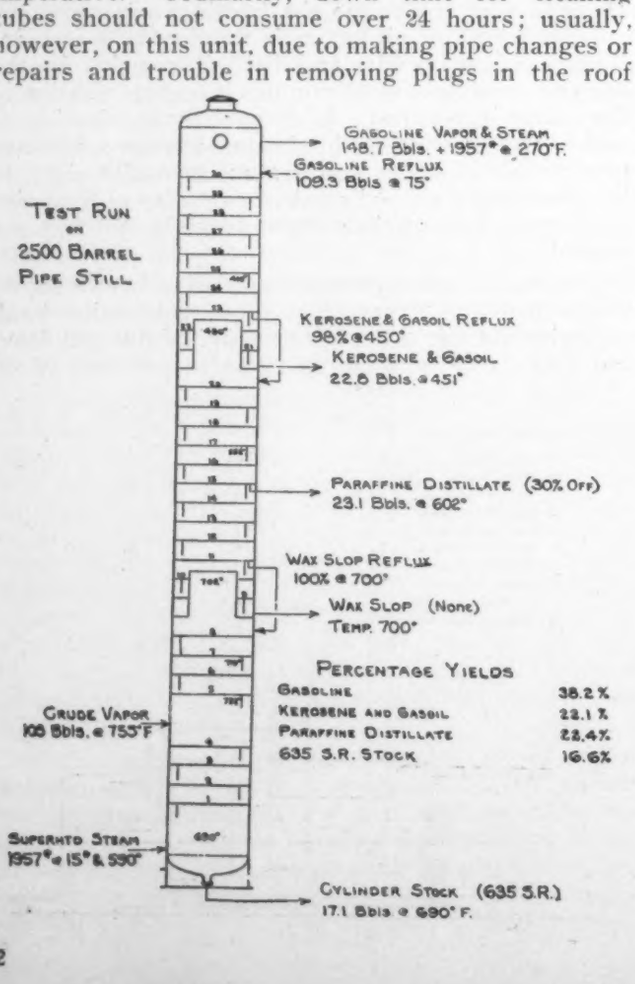
FUELS

Fuel used can be either oil or powdered coal; very uniform operation can be maintained with fuel oil. While some trouble has been experienced with ash disposal on powdered coal installation, there is every reason to believe that ultimately powdered coal fuel will be used, with oil burners for standby service and for use in starting up the still when cold.

Cleaning of the heater is necessary about every six to eight weeks, this depending upon the transfer temperature carried at the heater outlet and rate of deposition of solid matter from the crude. It has been found on this unit that when an 800 degree F. or higher transfer temperature is used, some cracking and coke deposition occurs, also that the deposit is slightly greater at the bottom of the tube where the greatest heat application occurs, this being in the lower row of roof tubes which are closer to the direct flame and have more of the oil in liquid phase due to the higher pressure and lower temperature. These show a slightly greater amount of coke than the upper row.

All tubes are rolled into return bend headers, the roof tubes having patented return flow headers for cutting down the pressure drop. Cleanout plugs are the locking type for quick removal and replacement.

Convection tubes all have the box type of return headers with screw plugs. After a year of operation cleaning of all of the convection tubes was not found necessary and need for cleaning any of them was not imperative. Ordinarily, down time for cleaning tubes should not consume over 24 hours; usually, however, on this unit, due to making pipe changes or repairs and trouble in removing plugs in the roof



tubes, several days were required. Taper of the plugs was not enough to allow breaking out easily after the mixture of sealing oil and graphite had coked together under high temperature.

Leaking plugs were never a source of trouble, partly because each time after cleaning and replacing plugs the heater was pumped full of oil and pressure test (cold) of about 175 pounds made before firing the still.

The fractionating tower is six feet six inches in diameter by 76 feet high, one-half-inch steel plate, butt strap riveted, and welded. It is equipped with 30 bubble trays and caps spaced on 20-inch or 24-inch centers and has internal stripping sections and side cut takeoff lines for removal of gas oil and paraffin cuts.

Off the bottom of the tower is a six-inch line for removal of the residuum; the lower four feet of the tower is for accumulation of this cut and stripping of light ends with superheated steam discharged through a spider into the oil. Above this accumulator are four bubble trays in which most of the stripping is actually done by the steam blowing through the descending oil.

The six-inch vapor or transfer line from the heater enters the tower above the fourth tray, dropping the heavy ends to be stripped onto the tray and the light fractions rising through two strip grid baffles and then through tray No. 5.

Trays 5, 6, 7 and 8 are for fractionating of the heavy ends of the rising vapors, and above tray 8 is a stripping section.

This section was originally intended for stripping and removal of paraffin cut, but it was found that in production of cylinder stock bottoms of 200 viscosity at 210 degrees or higher, a wax slop cut of several per cent was necessarily taken off at this point to give both good paraffin and cylinder stock.

Still later it was developed that with higher transfer temperature and 100 per cent reflux around the wax slop stripping section it was possible to take off a good cylinder stock up to 200 viscisity at 210 degrees F., but in either case it was necessary to take out the paraffin at a higher point in the tower.

The internal stripping section as arranged above tray 8 consists in blocking off the tower except for a riser 36 inches by 42 inches by 48 inches high through which the vapors must pass. Trays 9 and 10 are stripping trays with vapor opening cut down 50 per cent by the riser extending through the center. On the bottom plate of this section is a stripping steam spider and from the side of the tower a three-inch drawoff line for the stripped product. Gauge glass inside of tower indicates level and whether removal is being properly made.

Tray No. 11 is the first complete fractionating tray above No. 8 and the liquid reflux from this tray can be discharged onto tray No. 10 in any desired proportion by an outside controlled, internally acting, slide takeoff box. The function of this valve is to remove from tray No. 11 such part of the liquid as is desired to be used as reflux on tray No. 8 with the remainder going down to tray No. 10 for stripping and removal, or conversely, putting any desired amount on No. 10 for stripping and removal, with the remainder bypassing the stripping section and being used as hot reflux on tray No. 8.

With this arrangement it is necessary that other

factors, namely, transfer temperature and reflux higher in the tower be properly adjusted to give the amount of liquid reflux from tray No. 11 for proper amount of reflux to No. 8 and proper quality takeoff from the section.

FLASH TEMPERATURE

The reflux line from the takeoff box is six inches with a six foot loop below entrance on No. 8 tray for a seal to prevent vapors rising through the line and bypassing trays 9 and 10 outside the tower.

Nine trays occupy the space below the next stripping section and above tray No. 11. Off tray No. 15 is the paraffin line, through a graduated valve similar to that in use on tray No. 11; however, in this case the stripping section has not been found necessary. The amount of paraffin cut removed is controlled by laboratory tests. For example, in case the gravity is too high and viscosity too low the slide valve is pulled out a little, which results in a smaller percentage and volume being taken off. Then by bringing up the transfer temperature slightly to overcome the effect of the increased reflux the unit is brought back to balance, now taking off a smaller yield of lower gravity and higher viscosity product.

If it had been found necessary because of low flash to install a stripping section this would have been done, but the flash has easily been kept at 300 degrees or higher.

Above tray No. 20 is a stripping section similar to that above tray No. 8. Trays Nos. 21 and 22 are stripping trays similar to 9 and 10, and tray 23 is equipped with graduated valve similar to trays 11 and 15 with operation similar to that on No. 11.

Trays 24 to 30 inclusive are gasoline fractionating trays, the cold gasoline for tower head control being introduced directly on tray 30 through a three-inch line from the reflux pump.

Above this point are three sets of strip grids and on opposite sides of the tower two 12-inch vapor lines.

This constitutes the principal construction of the tower; summarizing, there are four trays for stripping of bottoms below the vapor entry, four trays above for heavy oil fractionation, then the wax slop stripping section, and two stripping trays in same, above which are five trays and the paraffin takeoff tray. Five more trays are below the kerosene and gas oil stripping section, and above this are the final eight gasoline fractionating trays.

In starting up the tower when the side cuts are not of proper quality for removal, drainage lines are provided, teed into the takeoff lines and discharging to trays six and 18. These lines also are for removal of water which at the start would condense on the takeoff pans and possibly be vaporized suddenly when the temperature became high enough.

It might be interesting in passing this point, that while each time the tower has been started up most of the bubble trays were full of water, never has the slightest gurgling or thumping indicated that sudden vaporization of water was taking place. On the contrary, as the tower head came up to the boiling point of water large volumes of water came off as evenly as could be desired, and the tower head remained at about 210 degrees until all of the water had ceased to come off.

At the top of the tower as a safety release is installed a six-inch weighted pressure relief valve set for about four pounds. A mercury manometer is set in the top of the tower also, indicating pressures of around 1½ pounds normally, this being due to drop through the vapor heat exchanger and lines.

UNIFORM END POINT

Uniform end point overhead is made by control of direct reflux to top of tower through automatic electric controller and hand operated valve in parallel. This gives a head temperature which varies only a few degrees.

At the bottom of the tower a pressure manometer is installed for determination of pressure drop through the tower. This usually shows between 2½ pounds and three pounds, indicating a drop of 1½ pounds through the 30 bubble trays.

For constant control of bottoms level in the tower there is a float mechanism which regulates the flow of bottoms from the tower chamber.

Removal of cuts from the tower is accomplished in several ways. Bottoms are pumped, due to low head and high viscosity. The wax slop cut drops through the cooler box, rises in a vented line to almost the level of the takeoff, and then gravitates through the receiving house look-box to tankage. Removal of paraffin cut and kerosene and gas oil cut is also made in this way, the compensating risers being provided to hold a liquid level in the takeoff lines almost back to the tower, preventing thereby siphoning and condensation of light vapors with the side products. This scheme works very nicely and flash tests on cuts show that no vapor loss is taking place.

The overhead gasoline fraction is run through the vapor heat exchanger and cooler by gravity, through the look-box, and out to tankage.

As auxiliary equipment, this still has one vapor heat exchanger followed by a water cooling section on the overhead line, and a liquid to liquid heat exchanger on the bottoms line.

The vapor exchanger easily cools the overhead stream to 80 degrees, but considerable trouble has been experienced with it due to it not being designed to operate at the high pressure found necessary.

The bottoms exchanger, as mentioned later, is not getting good heat exchange and has pulled some tubes by unequal expansion.

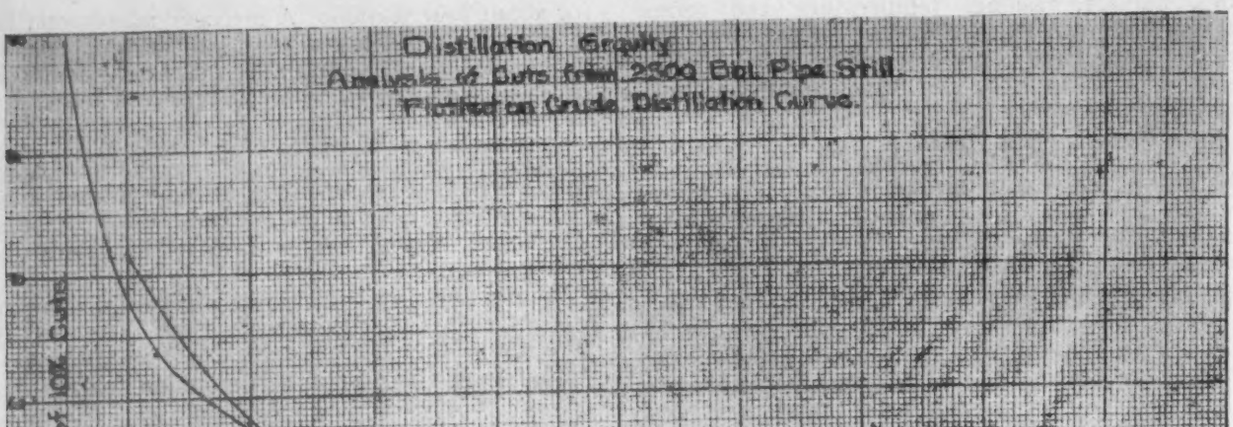
The crude supply is pumped from either of two supply tanks with an electric centrifugal pump. For standby, a steam pump is in the line, ready to be cut into service whenever necessary on account of power failure.

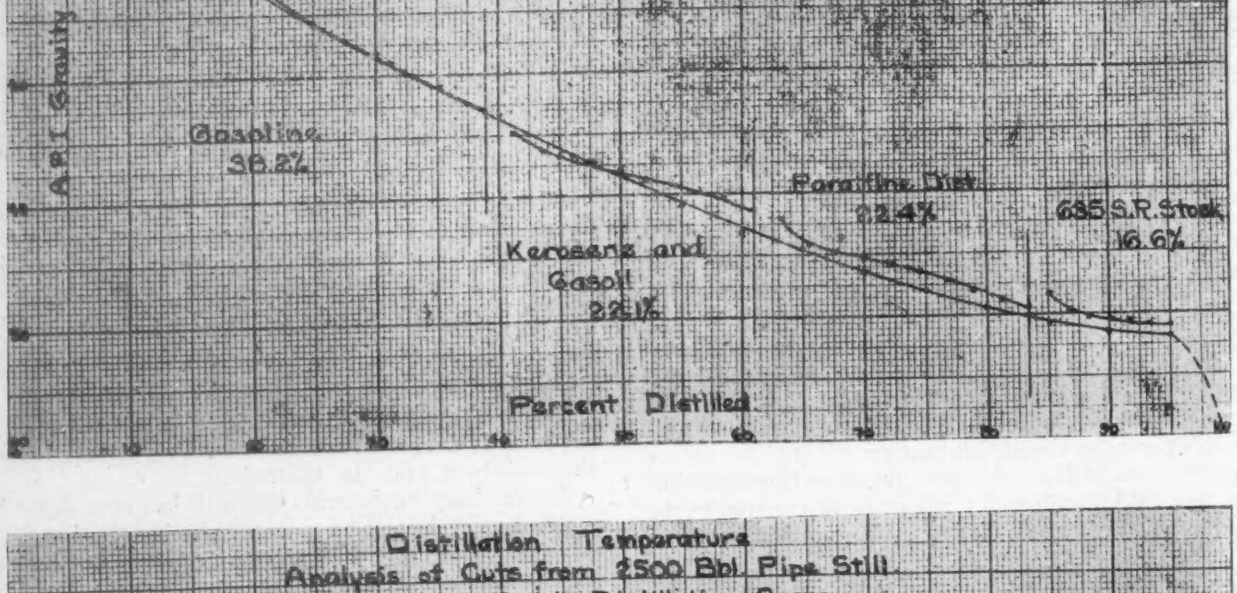
From these pumps the crude goes through a meter and then up through the vapor heat exchangers where a pre-heat of 230-240 degrees is obtained. From this set of exchangers it passes through the bottoms exchanger where the preheat is increased to 250 to 260 degrees and then into the heater.

The reason no other exchangers are in use on the side cuts is because this unit was originally designed to run for 40 per cent long residuum bottoms with side cuts of gas oil and kerosene; under such conditions a large amount of bottoms at high temperature would furnish considerable preheat to the crude. Under present conditions, making roughly 15 per cent bottoms, less heat is available and greater loss occurs by sensible heat in side cuts.

PUMPS

The pump house has two steam duplex pumps which pull the bottoms through the residuum ex-


Distillation Gravity
Analysis of Cuts from 2500 Bbl. Pipe Still
Plotted on Crude Distillation Curve.
A.P.I. Gravity of 10% Cuts
Gasoline
38.2%
Kerosene and
Gasoil
22.1%
Paraffine Dist.
22.4%
685 S.R. Stock
16.6%
Percent Distilled


Distillation Temperature
Analysis of Cuts from 2500 Bbl Pipe Still
Plotted on Crude Distillation Curve.
Vapor Temperature (°F)
685 S.R. Stock
16.6%
Paraffine Dist.
22.4%
Kerosene and
Gasoil
22.1%
Gasoline
38.2%
Percent Distilled

changer and cooler and discharge out to stock tanks. Only one of these pumps is in use at a time, the other being kept ready in case a breakdown on the first necessitates its use.

The gasoline reflux pumps are also two in number, the first an electric driven centrifugal pump and the other a steam-driven duplex pump.

The value of having two pumps for each service lies in the fact that a breakdown on any pump does not necessarily require shutting down the still until repairs have been made, and allows all of the pumps to be kept in good operating condition at all times.

Also in the pump house is the manifold line for delivering exhaust steam from any steam pump in operation to the superheater, with a regulator and reducing valve in the plant high pressure steam line for supply of makeup steam. By this system, holding constant pressure on the superheater and uniform flow of super-heated steam to the tower is possible, with complete recovery of exhaust steam from the pumps.

Outside the pumphouse, underneath the deck connecting tower and receiving house, are manifolds and cross-over valves for switching pumps. Here also connection is made for pulling tower bottoms with steam crude pump and discharging back to crude tank or through heater again. This arrangement is used when still is started up, circulating the bottoms in the tower back through the heater until all water is off the tower and side cuts are started.

The receiving house is located over the pumphouse and contains the look-boxes and rundown lines on wax slop, paraffin distillate, kerosene and gas oil, and gasoline streams. The three-inch reflux line passes up through the house and control of reflux either by hand valve or automatic controller is made here and resulting head temperature observed.

Gasoline tanks are used both for rundown and reflux feed. In practice the overhead is run into a tank until it is full, then the water is drawn off and the gasoline held for reflux, or if sufficient reflux is on hand in another tank this stock is transferred to the agitators.

OPERATION

Beginning with the unit shut down, say after cleaning tubes, the following method is used in starting up:

1. Inspect whole unit to see that proper valves are open or closed, go over heater plugs, and line up for starting crude feed through exchangers and into heater.

2. Watch for leaks as heater is filled up and when oil starts to run out of heater into tower pinch down on outlet valve and build up test pressure. As soon as this test has shown that all high pressure equipment is in satisfactory condition, fill the bottom of the tower until about two inches shows in the gauge glass, close off the crude supply line, and open the bottoms line to circulate bottoms slowly through the heater.

3. Start slow fire in heater and bring up slowly to protect brickwork, watch oil outlet temperature. As level in tower drops due to vaporization of light ends, cut in small flow of fresh crude to hold same.

4. Cut back side cut lines and reflux loops to tower and drain water out of bleeders in bottom of loops. Keep these loops clear of water.

5. Start small amount of steam through superheater into bottom of tower as soon as oil temperature is up to 212 degrees F. Also set graduated reflux valves at setting found by previous experience to be about right to make desired quality and volume of side cuts.

6. Watch top of tower temperature and rate water comes off. When temperature starts rising to 225 to 250 degrees, make another inspection of loops and draw off water. Start taking out side cuts, stop recirculation and start drawing bottoms to hold tower level, feed all fresh feed into heater. Start water through lower sections of vapor exchanger.

7. Increase superheated steam, raise transfer temperature to about 600 degrees F., start feeding gasoline reflux when top of tower temperature is up to 275 degrees F. and gradually bring still up to operating conditions.

8. Raise transfer temperature and feed rate to schedule. Check over all valves and lines to see that everything is running properly.

9. Start taking operating data, gravities, and tests on cuts. When flash and viscosity on bottoms are to test cut into stock tanks.

Three men are used per shift to run this still, one stillman in charge who makes valve changes and watches entire operation of the unit, one fireman who takes data on the heater and regulates the fire, and one pump man who watches the bottoms level, steam pumps, draws water on rundown tanks, and helps out the stillman and fireman.

The necessity for the third man is due to the stillman making hourly flash tests on the still bottoms, and because the rate of bottoms drawoff using the level controller has varied beyond desired limits. While two men could probably operate the still with entire satisfaction, in the event of a pump breakdown at night or other trouble the presence of the third man might be very necessary.

Each morning, from the running cards to 7:00 A. M., a report of operations for the past 24 hours is made up covering such data as is necessary. A typical copy of this is as given below:

Bbl. Crude thruput by meter	2528.0
Bbl. Crude thruput per hour	105.3
Average Gravity Gasoline	59.9
Average Gravity Kerosene and Gas Oil	41.3
Average Gravity Paraffin Distillate	33.6
Average Gravity Wax Slop	——
Average Gravity Bottoms	25.0

TESTS ON STOCKS

	Paraffin Distillate	600 S R Stock
Flash	315°	545 (P.M.-515)
Fire	400	625
Viscosity	84@100°	158@210°
Pour	75	30
Tar	..	.037%

HEATER OPERATION

Furnace Temperature, West Side	1186°F.
Furnace Temperature, East Side	1183
Per cent CO_2	11.5%
Furnace Draft	.02" H_2O
Pounds Coal Burned	30,350
Pounds Coal per Barrel Thruput	12.0
Temperature Oil Entering Heater	247°F.
Temperature Oil Leaving Heater	710°F.

Pressure Oil Entering Heater	104 lb.
Pressure Oil Leaving Heater	10 lb.
Pressure Steam Entering Superheater	25 lb.
Pressure Steam Leaving Superheater	15 lb.
Temperature Superheated Steam	598°F.

TOWER OPERATION

Wax Slop Reflux Valve Setting	100%
Kerosene & Gas Oil Reflux Valve Setting	87%
Paraffin Takeoff Valve Setting	29%
Pressure Bottom of Tower	2⅝ lb.
Pressure Top of Tower	1⅜ lb.
Temperature Crude Leaving Vapor Heat Exchanger	228°F.
Temperature Crude Leaving Bottoms Exchanger	247°F.
Temperature Bottoms in Tower	664°F.
Temperature Bottoms Leaving Exchanger	480°F.
Pressure Crude Entering Vapor Heat Exchanger	130 lb.
Pressure Crude Entering Bottoms Exchanger	121 lb.
Temperature Top of Tower	270°F.
Average Flash on Bottoms (Open Cup..)	545°F.

These results are indicative of operation when reducing to 600 S R stock, this being the lightest cylinder stock made. When orders require by increasing the transfer temperature, the bottom flash and viscosity can be raised to produce a 620 or 635 S R stock, and by taking off 4-5 per cent of wax slop and using about 780 degrees transfer temperature, a 590 degree flash, 232 viscosity, 650 S R stock is produced. It has not yet been found possible to remove 650 stock without taking out the wax slop cut. If this is not done the paraffin cut suffers by carrying with it a fraction of amorphous wax which may press but hinders sweating considerably. Otherwise the paraffin cut can be handled satisfactorily, especially when mixed with shell still rerun paraffin distillate.

TESTING

During the greater part of the past year, since the start of operations, tests have been made on this unit to improve results.

Originally planned to run for 40 per cent. long residuum bottoms, gas oil and kerosene side cuts, and gasoline overhead, in the absence of a dewaxing plant the still was started to take off a 30 per cent. combined cylinder stock and wax distillate, gas oil and kerosene side cuts, and gasoline overhead. Still transfer temperature was carried at 600 degrees F., the bottoms were mixed with crude and rerun on the shell stills for cylinder stock.

Gasoline yield was 40-41 per cent. but the kerosene yield only 4-6 per cent. with a low gravity and close distillation range. The only way to secure a kerosene cut which would meet gravity and shipping specifications would be to take part of the heavy end of the gasoline cut and incorporate this in the kerosene.

The gas oil cut had a high initial and no content of viscous oil.

CORROSION

On reducing the bottoms in shell stills, due to the concentration of heavy ends it was found very difficult to get low tar content on 635 or 650 stock. 600 and 620 S R bottoms were about the heaviest which could be made successfully.

After several months of operation it was found that the overhead vapors were very corrosive toward the steel rundown lines and had eaten entirely through some of the nipples on the look-box manifold. Feeding strong liquid ammonia solution into the crude and testing overhead water with phenolphthalein was resorted to and successfully neutralized the overhead, but feeding such a small amount of ammonia through a needle valve could not be made uniform enough to give satisfaction. Recently, neutralization has not been made but all parts subject to corrosion have been replaced by cast iron.

A point to remember in this type of corrosion is that it is due to hydrochloric acid from decomposition of chlorides and does not have any appreciable effect until after condensation of steam takes place. Then it cuts into steel rapidly along the bottom of lines, but leaves cast iron and malleable fittings apparently entirely unaffected.

A further difficulty has been the formation of a sort of iron sulphide sludge in the tanks and reflux lines as a result of this corrosion. Several times when the reflux pump seemed unable to pump back a sufficient supply to the tower it was found on breaking into the suction line at the pump that the opening in the pipe had been decreased to about 1 inch by the building up of this sludge in the line.

To decrease the pressure drop through the heater all of the return boxes on the roof tubes were changed. These had originally been the square box type with screwed plugs; they were changed to the return flow type with locking plugs, in which no turbulence or restriction should occur.

Data on runs before an dafter the change in these headers is not quite comparative but indicates at least 15 per cent. and possibly 20 per cent. greater throughput capacity with the present headers.

The bottoms from the tower with the 600 degrees transfer temperature, gave no indication from color or tar content that crackling occurred. To make flash and viscosity test cylinder stock direct from the still was a problem on which no information was available and which could only be proved operative by actual trial.

The transfer temperature was accordingly increased to 700 degrees F. and samples off the bottom of the tower were 540 degrees-545 degrees flash with a viscosity of about 200 seconds and very low tar content. The lower side cut ran a heavy paraffin distillate, and off the upper tray removal of a combined kerosene and gas oil was made. The amount of reflux required into the top of the tower was considerably increased to remove the greater amount of heat coming into the tower. Also more superheated steam was put into the bottom of the tower for the purpose of driving off the light ends.

Operation in this manner was carried on for quite some time, running about 1800 barrels per day, and making adjustments in the reflux valve settings to

The record production of automobiles this year, with every indication that next year will break the existing record, promises a greatly increased demand for gasoline in 1929

To be prepared to meet this increased demand every refiner should install the Dubbs Cracking Process, crack low priced fuel oil by the non-residuum method and produce maximum yields of gasoline

Maximum profits will follow

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

get better products. The paraffin cut continually ran too high in viscosity and contained some light ends of the cylinder stock fraction, while the bottoms were satisfactory in regard to flash but were also high in viscosity due to loss of the low viscosity ends in the wax cut.

PARAFFIN CUT

The next change was in the addition of a paraffin line off No. 15 tray, the former paraffin takeoff now becoming a wax slop line. Operation with this new line immediately gave a good paraffin cut; however, 4-6 per cent. wax slop of 30 degrees gravity and high viscosity was taken off in order to give proper flash bottoms. Development further gave 600 S R bottoms in which the wax slop cut was refluxed entirely and none removed. Transfer temperature was raised somewhat and steam increased into the bottoms to allow this.

In connection with the use of superheated steam, it has been found that about 600 degrees F. is as high as the superheat temperature should be allowed to go to prevent cracking of the bottoms in the accumulator. For a considerable period open cup flashes on cylinder stock were regularly held as desired, but on these same stocks Pensky-Marten flashes were too low. During this time superheated steam was used at 760-780 degrees but it was not thought that this would have any detrimental effect since any light vapor formed should be removed by the steam which caused the cracking. However, since using superheated steam at 600 degrees F. Pensky-Marten's flashes have risen 40-50 degrees from which we are led to conclude that too high superheat on steam can be detrimental. The upper safe limit can possibly be as high as the temperature of the bottoms which are being stripped, but in this case at least cracking resulted without the light vapors formed being entirely removed.

The final development was in the production of 635 S R stock, 575 degrees flash, 200 viscosity at 210 degrees material with the following results on a test over a six-hour period:

	Bbl.		Bbl.
Total Crude Yield	618.2	Hourly	103.0
Total Gasoline Reflux Feed	655.88	"	109.3
Gasoline Yield	236.15	"	39.35
Kerosene and Gas Oil Yield	136.62	"	22.77
Paraffin Distillate Yield	138.48	"	23.08
635 S R Stock Yield	102.62	"	17.10
Loss and Errors	4.33	"	.70
Per Cent. Gasoline			38.2
Per Cent. Kerosene and Gas Oil			22.1
Per Cent. Paraffin Distillate			22.4
Per Cent. 635 S R Stock			16.6
Per Cent. Loss and Errors			.7
			100.0

TESTS ON CUTS

			Kerosene & Gas Oil	Paraffin Distillate
Gasoline	Overhead	Reflux		
Gravity	59.3	59.1	41.6	33.3
I. B. P.	122	121	438	578
10%	180	178	462	652
20%	214	212	478	665
30%	240	237	489	684
40%	263	259	499	697
50%	287	286	512	712
60%	308	309	526	728
70%	332	333	540	744
80%	359	362	559	760
90%	392	392	586	776
End Point	428	432	607	...
% at 221	23.0	23.5	...	...
% at 284	49.0	49.5	...	...
% at 392	90.0	90.0	...	...
Flash	...	...	...	330
Fire	...	...	...	405
Viscosity at 100.	...	...	...	85
Pour	...	...	...	75

Crude Feed

Gravity	41.2
I. B. P.	141°
10% at	246
20% at	306
30% at	397
36% at	437
37.5% at	455

Bottoms

Gravity	24.5° A. P. I.
Open Cup Flash	575° F.
Pensky-Marten Flash	540° F.
Fire	665° F.
Viscosity at 210°	199
Pour	35
Tar	.056%
Color	S R G

HEATER OPERATION

Furnace Temperature: West Side 1280° F.
East Side 1260° F.
Flue Gas Temperature 420° F. Per cent CO_2 8.5.
Draft. 02" H_2O.
Barrels Fuel Oil Burned 18.4 bbls. % on Crude 2.96.
Temperature Oil into Heater 259°. Leaving 753°
Pressure Oil into Heater 108 lb. 10 lb.
Pressure Steam into Superheater 25 lb. Leaving 15 lb.
Volume Superheated Steam 1957 lbs./hour.
Temperature 590°
Lbs. Steam per Barrel Crude 19.0
Lbs. Steam/Gal. SR Stock 2.72

TOWER OPERATION

Kerosene and Gas Oil Reflux	98%
Paraffin Takeoff	30%
Wax Slop Reflux	100%
Pressure Bottom of Tower	2¾ lb.
Top of Tower	1⅜ lb.

Temperatue Crude Leaving Vapor Heat Exchanger	210° F.
Temperature Crude Leaving Bottoms Exchanger	260° F.
" Bottoms in Tower	690° F.
" " Leaving Exchanger	520° F.
Pressure Crude Entering Vapor Exchanger	133 lb.
Pressure Crude Entering Bottoms Exchanger	127 lb.
Temperature Top of Tower	270°
Average Flash on Bottoms	575° F.
Pensky-Marten's Flash	540° F.

TEMPERATURE VARIATION DURING TEST

Heater Inlet	1° F.
Heater Outlet	8° F.
Ent. Top Row Roof Tubes	5° F.
At Paraffin Takeoff	7° F.
In Bottom of Tower	9° F.
At Top of Tower	None
Temperature Drop Through Transfer Line	None

The curves showing analysis of cuts were made from vacuum assays on a Hempel flash and initial boiling points are not quite comparable to the results which would be secured on an A S T M 100 c.c. flask, but these curves show that very well fractioned products are being made.

Refining of Gasoline Distillates from West Texas Crude

(Continued from page 90)

treatment gives no desirable results which cannot be more economically obtained in other ways.

VAPOR PHASE TREATMENT

A considerable number of experiments were carried out in an attempt to reduce the sulphur content of gasoline by treatment in the vapor phase. Experimental runs were made using fuller's earth, bauxite, pumice wet with phosphoric acid, and oxides of calcium, barium, cadmium, and aluminum. Towers containing these solids were used in connection both with straight fire distillation and distillation with fire and steam. Further experiments were carried out in which the gasoline vapors were conducted through tubes containing these solids at temperatures of 600-1000 degrees F. Certain combinations of conditions resulted in a gasoline which was wholly or nearly sweet, but in no case did the sulphur content of the gasoline seem to be appreciably reduced.

METALLIC CHLORIDES

From a theoretical standpoint the use of anhydrous chlorides of the bivalent, trivalent, and tetravalent metals seemed to offer particular promise of success, since it is well known that these salts show a marked tendency to form addition compounds with many organic compounds which possess the secondary valence that we might expect from complex sulphur compounds. Because of these hopes our experiments were all the more disappointing, leading as they did only to negative results. Considerable work was done with mercuric chloride, cuprous chloride, and cupric chloride, with water, hydrochloric acid, and ammonium hydroxide as solvents. In no combination of conditions did these salts seem to affect the sulphur content of the gasoline. The chlorides of copper seemed to form no addition compounds, or at most, compounds which were very unstable. Mercuric chloride, on the other hand, seemed to form compounds which tenaciously resisted any attempt to wash them out of the distillate: on evaoporating a distillate which had been treated with mercuric chloride, the gum which was obtained was coated with droplets of metallic mercury. As has been stated above, the use of saturated aqueous solutions of mercuric salts (particularly mercuric acetate) in conjunction with a sulphuric acid treatment seems to reduce the sulphur by 0.04 per cent. or 0.05 per cent. below that attainable by the use of acid without the mercuric salts. This is possibly due to the formation of addition compounds by the organic sulphur compounds and the mercuric salts, part of which are removed in the aqueous solution and the remainder of which are made more susceptible to the action of sulphuric acid.

The anhydrous chlorides of trivalent and tetravalent metals—aluminum chloride, antimony chloride, bismuth chloride, ferric chloride, stannic chloride, and titanic chloride—will, in general, sweeten the gasoline, but fail to decrease its sulphur content. That these salts actually form addition compounds with some constituents of the distillate is indicated by the high gum content which the distillate shows before rerunning. The most active of these salts are the chlorides of aluminum, antimony, and tin. Aluminum chloride seems to have a particularly marked action, and our results indicate that this salt tends to convert unsaturated compounds to saturated compounds rather than to remove the unsaturates. A sample of West Texas distillate after treatment with aluminum chloride gave practically no color when shaken with sulphuric acid according to the usual test for unsaturates, and its color remained 30 Saybolt after more than a year's exposure to sunlight.

CONCLUSIONS

The problems confronting the refiner who wishes to use West Texas crudes is three-fold. First, he must make the best use of the facilities which he has in regulating his refining process to give products which are as low in sulphur as possible. This involves suitable choice of topping, cracking, and rerunning operations, possible desirability of blending gasoline from West Texas crudes with gasoline from sweet crudes, etc. Second, he must determine the best way to adapt the customary acid-doctor-rerun treatment to the product which he has to turn out and the equipment he has to work with. Third, he must bear in mind that the treatment of West Texas distillates presents a new and tremendously important problem to the industry, which can be solved only by the most careful study, and which will generously repay a successful solution.

A complete service for the installation of petroleum

In its more than a quarter century of service the J. P. Devine Manufacturing Company has consistently pioneered with safety in advance of accepted practice. The two-fold result has been evidenced in universal use of Devine equipment and an equally wide recognition of the company's position.

We offer the petroleum refining industry a service identical in policy and scope to that which has penetrated every phase of the Process Field. Regard the J. P. Devine Manufacturing Company as first an organization of consultants.

New York Headquarters
51 E. 42nd Street

J. P. Devine Man

Main Office

Plants: Buffalo, N. Y., and Mt. Vernon, Ill.

Mention Where You Saw the Advertisement

design, manufacture and refining equipment

The question of new equipment is ever present and is always timely. The forward minded executive considers the actual expenditure of funds last — and that is in its proper sequence. He first determines operating efficiencies. He seeks out expert pronouncement of established fact. He forms no opinions. He deals entirely in decisions which are based on fact.

When cost of operating with present equipment and the clearly indicated cost of operating with the new are compared he has the answer. We will be glad to have our engineers work with your own staff on your cost and production problems.

ufacturing Company, Inc.
Buffalo, New York

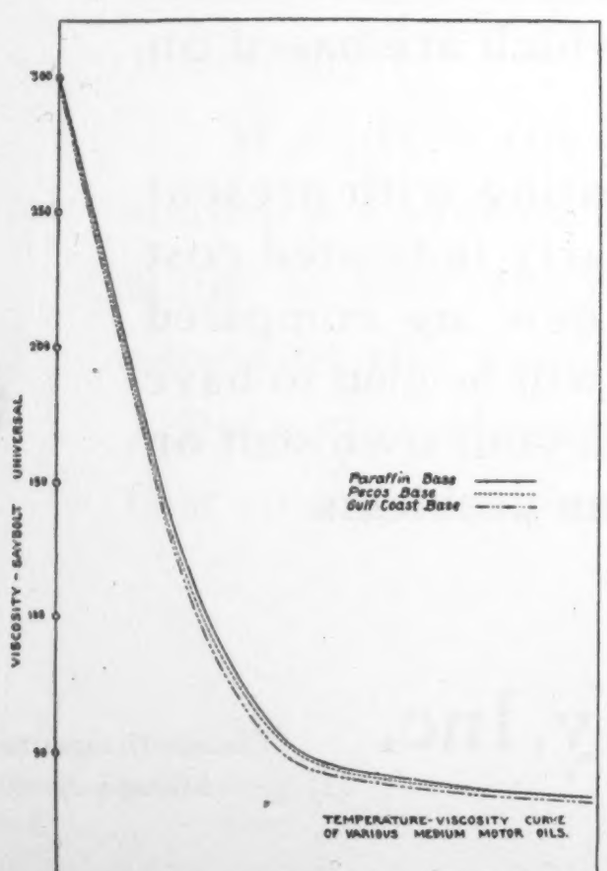
Chicago Headquarters
122 South Michigan Avenue

The Refining of Pecos County, Texas, Crude Oil

By SIDNEY BORN,
Transcontinental Oil Company

THE Yates Pool in Pecos County, Texas, was opened by a well completed October 28, 1926, by the Transcontinental Oil Company and the Mid-Kansas Oil & Gas Company. Since that time, more than 270 producing wells have been completed covering a productive area of over 14,000 acres. The productive sand is reached at depths varying from 900 to 1700 feet. An open flow test of this field was made on September 15, 1928, and showed a production of 3,835,651 barrels daily.

The average crude oil produced in this field shows a Baume gravity of 29.6 degrees and the sulphur content is 1.55 per cent. One of the characteristics of this crude is its low pour test, which is a decided advantage as it enables the oil to be handled readily through pipe lines at all times of the year. The viscosity of this crude has been determined at various temperatures and the results are given in graph "A." Another remarkable property of this crude is the fact that gasoline produced from it by direct distillation has a high anti-knock value. Engine tests show that the straight run gasoline from Pecos crude has an automotive equivalence of 47 per cent benzol in admixture with Pennsylvania straight run gasoline.



Pecos crude contains considerable amounts of lubricating oil, having a naturally low pour test, the lubricating oil fractions being obtained by direct distillation without the necessity of processing the distillate by means of refrigeration. Detailed analyses are given herewith showing the chemical and physical properties of this crude and the various distillates obtained therefrom.

By simple skimming distillation, 25 per cent of 437 end point blending naphtha can be removed, leaving a topped crude having an A. P. I. gravity of 22.1 degrees and a sulphur content of 1.84 per cent. This topped crude can be cracked[1] directly, producing 45.40 per cent of cracked gasoline, 9.50 per cent. of pressure distillate bottoms and 18.10 per cent of coke and gas. If the pressure distillate bottoms are recycled, the total yield of cracked gasoline will be 49.40 per cent., making a combined yield by cracking and topping of 74.40 per cent. In the above process 37 pounds of coke and 428 cubic feet of gas are produced per barrel of original crude oil.

CRACKING YIELDS

If it is preferred to crack to a heavy fuel oil, the following yields will be obtained:

Blending Naphtha	25.00%
Cracked Gasoline	41.50%
Pressure Distillate Bottoms	3.70%
Bunker "C" Fuel Oil	20.20%
Loss (Coke & Gas)	9.60%

The blending naphtha produced by the topping operation has an A. P. I. gravity of 54.8 degrees, initial boiling point of 140 degrees, 20 per cent. over at 226 degrees, 50 per cent. over at 284 degrees, 90 per cent over at 366 degrees, and a maximum boiling point of 430 degrees. The initial and 20 per cent. point can be modified to meet United States motor gasoline specifications by the addition of a small percentage of casinghead gasoline.

The naphtha cut can be sweetened and made non-corrosive by treatment with caustic soda and litharge in the ordinary way. Our tests show that the best results were obtained by giving the naphtha a preliminary wash with three per cent. of 25 degree Baume caustic soda solution, following this up with five per cent. (by volume) of 18 degree "doctor" solution. The "doctor" solution contained the equivalent of one pound litharge per barrel of naphtha treated. .02 pounds of sulphur per barrel of naphtha was used to complete the reaction. Naphtha treated in the above manner was "sweet" and non-corrosive

[1]The results of "cracking" under various conditions are based on data obtained by the Universal Oil Products Company, Chicago, Illinois.

when treated according to A. S. T. M. Method No. D-130-27T.

TESTS ON PECOS COUNTY CRUDE

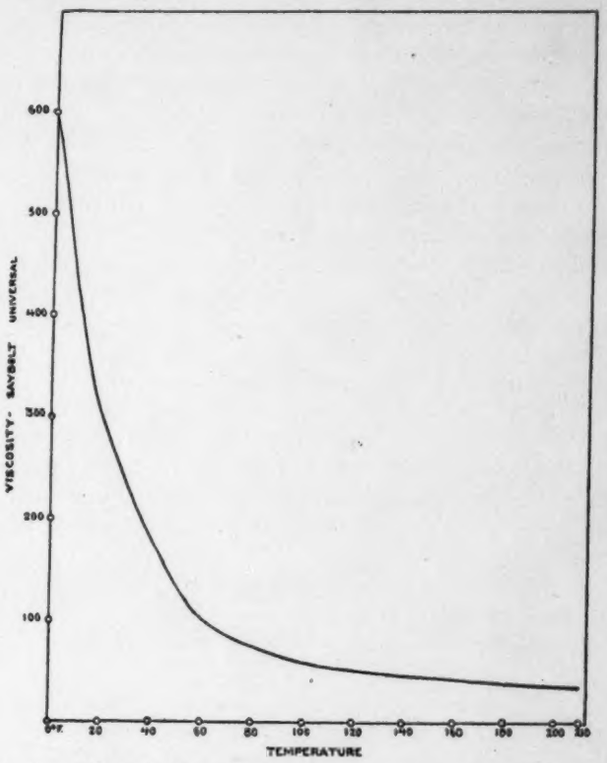
Gravity	29.6°
B. S. and Water	None
Sulphur	1.55%
Pour Test	Zero ° F.
Viscosity Saybolt Universal @100° F.	61

The fuel oil remaining after topping off 40 per cent. of the crude flows freely at zero, making it an especially desirable fuel oil for cold weather.

In running Pecos Crude to lubes, approximately 28 per cent. of gas oil is produced and this would make an excellent cracking stock. By cracking this fraction, approximately 45 per cent. of cracked gasoline could be obtained therefrom, which would increase the gasoline yield of the crude about 12 per cent. The lubricating oil fractions can be readily treated, any desired color being obtained by the use of the proper amounts of acid and clay.

The lubricating oils made from Pecos crude were carefully tested to see whether these oils had any corrosive action on metals. Polished copper strips were immersed in the oil, heated to 212 degrees F. for a period of from one to eight hours. At the end of that time, the strips showed no discoloration, pitting or tarnish. Viscosities of the lubricating oil fraction from the Pecos crude were run at temperatures ranging from 100 degrees F. to 350 degrees F. and compared with typical samples of paraffine base and coastal lubricating oils. It is interesting to note that the Pecos lubricating oil viscosity curve followed the paraffine base oil curve very closely. The viscosity curves are shown in the graphs accompanying this article.

The crude oil from Pecos County we have examined is practically free from salt water; tests showing that only approximately 10 pounds of sodium chloride could be obtained from the distillation of a thousand barrels of crude oil. No magnesium or calcium chloride is present. In this respect Pecos County production differs markedly from Panhandle crude. Panhandle or Amarillo crude contains a large amount



Viscosity of Pecos Crude at Various Temperatures. Gravity of crude 29.6

Simple Distillation

Product	%	Grav.	IBP	20%	50%	90%	MBP	Flash	Fire	Pour T.	Visc.	Sulphur	Color
Naphtha	25.00	54.8	140	226	284	366	430	...	...	.....	.....	.....	.....
Burn. Oil	5.80	39.3	...	...	...	...	...	150	180	.....	.....	.....	.....
Gas Oil	11.30	34.8	...	...	...	...	...	185	215	.....	.....	.805%	.....
Hy. Dist.	28.50	25.7	...	...	...	...	...	280	325	Below 5° F.	72	1.708%	4½
Fuel Oil	26.70	14.9	...	...	...	...	...	520	600	.....	467	2,950%	.....
Loss	2.70												

Running to 300 Viscosity Lubes

Product	%	Grav.	IBP	20%	50%	90%	MBP	Flash	Fire	Pour T.	Visc.	Sulphur	Color
Naphtha	25.00	54.8	140	226	284	366	430	...	...	.....	.....	.....	.....
Burn. Oil	5.80	39.3	...	...	...	...	...	150	180	.....	.....	.....	.....
Gas Oil	28.10	29.7	...	...	...	...	...	225	265	.....	.....	.....	.....
300 Neut.	15.00	22.6	...	...	...	...	...	390	460	Zero	300	.....	3½
Hy. Neut.	8.70	21.3	...	...	...	...	...	515	600	10°	90@210°	.....	5 Red
Asphalt	15.00	...	...	...	...	...	...	580	690	.....	.....	.....	.....
Loss	3.40												

Running to 500 Viscosity Lubes

Product	%	Grav.	IBP	20%	50%	90%	MBP	Flash	Fire	Pour T.	Visc.	Sulphur	Color
Naphtha	25.00	54.8	140	226	284	366	430	...	...	.....	.....	.....	.....
Burn. Oil	5.80	39.3	...	...	...	...	...	150	180	.....	.....	.....	.....
Gas Oil	29.50	29.0	...	...	...	...	...	230	275	.....	.....	.....	.....
500 Neut.	22.30	22.3	...	...	...	...	...	425	480	0°	500@100°	.....	Red
Asphalt	15.00	...	...	...	...	...	...	580	690				
Loss	3.40												

of saline matter; tests showing as high as 447 pounds per 1000 barrels of crude, a large percentage of this being present in the form of calcium and magnesium chlorides.

SULPHUR COMPOUNDS STABLE

The percentage of sulphur present in a crude bears no relationship to its corrosive properties. The form in which the sulphur is combined determines this. Hydrogen sulphide seems to be the most active corrosive agent, although other sulphur compounds may cause corrosion due to oxidation to sulphurous and sulphuric acids. The exclusion of oxygen cuts down this phase of corrosion.

Generally speaking, crude oil containing more than four per cent. sulphur is classified as "sour," but in some cases, crudes having a sulphur content even lower than this are more difficult to refine than other crudes which have as high as two per cent. sulphur content. Crudes produced in California have a sulphur content running from as low as .2 per cent. to as high as four per cent., while Mexican crudes will run as high as five per cent. sulphur and probably the average of all Mexican crudes will run about three per cent. sulphur. There are many crudes produced in Wyoming which run over two per cent. sulphur. As we have indicated above, the sulphur content itself is no criterion of the corrosiveness of the crude itself.

A preliminary investigation of the nature of the sulphur compounds in the Pecos crude was undertaken and the following results were obtained:

Total Sulphur	1.55%
Sulphur as hydrogen sulphide	.026%
Sulphur as elementary sulphur	.025%
Sulphur as mercaptans.....	.052%

This analysis indicates that most of the sulphur is combined as stable sulphur compounds and further investigation substantiates the belief that most of the sulhpur is combined as a complex organic radical which is practically as stable as the hydro-carbons themselves. This stability is indicated not only by the failure to break down under high heat and pressure but also by their resistance to alkaline reagents. Pecos crude was heated with aqueous solutions of sodium hydroxide, sodium carbonate and "doctor" solution respectively, in a bomb up to a temperature of 375 degrees F. and a pressure of 175 pounds per square inch. Sulphur determinations made before and after the above treatment showed a reduction of only .15 per cent. in the sulphur content.

A study was also made of the sulphur compounds in the raw untreated Pecos naphtha using the method recently developed by Faragher, Morrell and Monroe, for the analysis. The following results were obtained:

Hydrogen sulphide	.003%
Elementary sulphur	.012%
Mercaptans sulphur	.044%
Disulphide sulphur	.032%
Sulphide sulphur	.082%
Residual sulphur	.049%
Total Sulphur	.222%

Based on today's market prices, Pecos crude shows a considerably better realization than Mid-Continent crude of the same A. P. I. gravity. Notwithstanding the above, the market prices of Pecos crude today is 30 cents per barrel less than that of Mid-Continent crude of the same gravity.

Wells now completed and geological data available indicate that West Texas contains the world's largest potential source of crude oil. Therefore, it is incumbent upon the petroleum industry to make a very careful study of this source of supply and of the various products which can be obtained by refining the same. Considerable work has already been done by the technical and manufacturing departments of various companies toward solving these problems. Considerable still remains to be done but we are quite certain that the oil industry with their technical, scientific and manufacturing staffs will solve these problems just as they have solved many more difficult ones during the past two decades.

Problems in the Desulfurization of Petroleum Products

(*Continued from page* 82)

In our own case, we at the present moment are cracking gas oil, and cracking heavy residue by means of Cross and Dubbs plants, and it is not astonishing that if you take one of those cracked spirits and refine it down to what might be called conventional standard of color, and of odor, to note that you have produced a material which has the same antiknock value as the straight run spirit from the same crude.

There is a case in which there is no doubt a large amount of education necessary in Europe. For the utilization of material that has no particular bad smell or bad color, but has a characteristic odor and color, this education will take a lot of time, but it will come inevitably.

There again the treatment that will be adopted in the future in all of these cases will be a treatment more definitely physical than chemical. We are watching with great interest on our side, the attempts made here in the way of treating cracked spirit vapors over polymerizing material in the nature of fuller's earth. That appears to me a line of extraordinary promise.

I merely want to mention one point in the question of desulfurization that occurs in our natural gases which run up to 14 per cent. or thereabouts of hydrogen sulphide. There we found a very simple and effective method based on the Claus process used for a long time in England, in which the gas is mixed with air and then passed through a contact bed, in which a simple reaction takes place that is thus: $H_2S\ 3\ 0 = H_2O\ 3\ S$.

The Relation of the Liquefied Petroleum Gas Industry to the Oil Industry

By R. C. ALDEN,
Phillips Petroleum Company

EVERY activity of every branch of the oil industry has its effect, great or small, on every other branch of the oil industry. Increased efficiency in any aspect of finding, storing, transporting, refining, marketing or using petroleum and its products means a measure of readjustment throughout the entire industry. Admittedly the overwhelming factor has been the volume of crude oil production but the oil industry is rapidly realizing that benefit or harm to one of its many ramifications is likewise beneficial or harmful to its entire structure.

Thus it is a matter of interest to the oil industry as a whole to learn that progressive representatives of the natural gasoline industry are strenuously opening new markets for certain products available as an incident to the manufacture of the more stable grades of natural gasoline. It is true, some of these markets are competitive with other products from petroleum, and as such will merely result in a readjustment within the industry, provided economic conditions justify a change. However, some of the new markets are in fields comparatively unexploited from a petroleum viewpoint and therefore represent means of increasing the total revenue of the oil industry.

The major function of the oil industry has been to provide fuels which can be conveniently and cheaply utilized in supplying mankind with light, heat and power. The magnitude of our resources has made petroleum a cheap fuel supply. The liquid nature of the products of petroleum has made it convenient to store, transport and use them. Liquid fuels from petroleum have generally found markets commensurate with their value while the gaseous products have been marketed at prices entirely out of line with prices for gaseous fuels from other sources.

Natural gas, a major product of the oil industry, is produced in large quantities but has difficulty in finding markets commensurate with its value. Natural gas is usually produced in districts remote from points of consumption. It cannot be stored and can only find markets through long and expensive pipe lines.

It has not been long since casinghead gas was a nuisance and the encountering of gas where oil was expected meant financial failure. Today the gas revenue to oil producing companies forms a considerable portion of the total revenue and not infrequently gas wells are more profitable than oil wells. This is due, of course, to the extraction of natural gasoline and the greatly improved facilities for distribution of natural gas. It is to be expected that diversified markets for the natural gasoline industry will further add to the revenue of the oil industry.

FINDING NEW MARKETS

In finding markets for liquefied petroleum gas, the natural gasoline industry is taking advantage of the natural economic benefits possessed by liquid fuels as far as storage, transportation and handling is concerned; and yet is supplying a material which has all the advantages of gaseous fuel in its use. In so doing, markets new and old to the petroleum industry are being solicited. Obviously this will have some effect upon all branches of the oil industry.

Although the subject of this paper is to discuss the relationship of liquefied petroleum gas to the oil industry a clear understanding of its exact status should include a short discussion of some of the uses to which the commodity has already been put. These uses can be briefly summarized as follows:[1]

"1. *Domestic Fuel* transported in cylinders, thus supplying gas to districts not now having that service. This use is a valuable ally to the gas companies as outlying districts can be serviced and held against encroachment by electricity or other fuels, pending gas main extensions. Commercial propane, being self vaporizing at all temperatures above minus 40 degrees F. is the most applicable and most widely used fuel for this 'bottled gas' service.

"2. *Industrial Gas* for various heating operations when the fuel consumption is large and where an economical but clean and easily controlled fuel is necessary. This phase of utilization, unless the marketing is controlled by the utilities themselves, is in direct competition with the industrial fuel sales efforts of the gas companies. Commercial butanes are best adapted to this exacting large-scale use.

"3. *Enricher for Manufactured Gas,* in place of gas oil to carburet producer gas, blue water gas or other gases of relatively low-thermal value to the required calorific standard. The efficiency of 'cold carburetion' is 100 per cent. Commercial butanes are most applicable here, due to their favorable physical characteristics.

"4. *Base Material for Manufactured Gas.*

a. Carburetting gases of little or no calorific value, these acting as diluents or carrying mediums. Exhaust or flue gases, or air are the materials commonly used.

b. Reforming or cracking high calorific value liquefied petroleum gas vapors to produce low-density gaseous fuel of the desired B.t.u. content.

Although the use of any of the standard grades is

[1] R. W. Thomas and O. M. Setrum "Commercial Propane and Butane in Manufactured Gas Industry"—1928 A. G. A. Convention.

practical for either of the above operations, nevertheless, the commercial butanes offer outstanding adventages and economies.

"5. *Commercial Solvents.*

"6. *Raw Materials for the Manufacture of Chemical Compounds.*"

FROM NATURAL GAS

At the present time natural gas is the major source of liquefied petroleum gas. The average composition of natural gas at the well is estimated to be about:

Methane	69%
Ethane	14%
Propane	9%
Butane	5%
Pentanes and heavier	3%

Methane and ethane are eliminated from the province of liquefied petroleum gases by their physical characteristics. Atmospheric temperatures are considerably above the critical temperature of methane while the critical temperature of ethane is about 90 degrees F. Propane and the butanes are the chief constituents of liquefied petroleum gas. The following table shows the vapor pressures of the paraffin hydrocarbons of which liquefied petroleum gas is composed.

TABLE 1

Vapor Pressure (Lb. per Sq. In.) of Propane, Iso-Butane and Pentane

	—50°F.	0°F.	50°F.	100°F.	150°F.
Propane	12.63	38.05	91.00	186.4	343.0
Iso-butane	3.21	11.67	32.30	74.0	144.2
Butane	1.86	7.35	21.55	52.5	107.5

The boiling points of propane, iso-butane, and butane are —47, 16 and 31 degrees F., respectively. It is evident that these hydrocarbons possess physical characteristics which bring their liquid state within the ecomics of modern engineering.

It is estimated that the production of natural gas in the United States contains propane and butanes in sufficient quantity to supply twice the heating value of the country's consumption of manufactured gas. This amount of liquefied petroleum gas would be eighteen million gallons per day.

This large supply of liquefied petroleum gas is not immediately available. To begin with, the design and operation of the average natural gasoline plant is such that of the gas processed about one-half of the available butane and one-eighth of the available propane are removed. However, it is a comparatively cheap and simple procedure to increase the quantities removed. Another consideration affecting the availability of liquefied petroleum gas is that butanes are normally included in large proportions in natural gasoline. It is estimated that the average natural gasoline contains about 28 per cent. butanes and lighter. From this viewpoint, the marketing of butane will be an economic struggle between the motor fuel markets and the new markets developed. A final consideration in regard to the availability of liquefied petroleum gas from natural gas is that its production is naturally more economically accomplished at large natural gasoline plants. It is too early to state what volume of production is essential to profitable operation, but there is a strong possibility that the smaller gasoline plants will find it uneconomic to manufacture liquefied petroleum gas.

FROM REFINING

Another considerable source of liquefied petroleum gas is the uncondensed vapors at refineries, and particularly at those refineries where cracking plants are in operation. It is noteworthy in this regard that many gasolines produced as a result of cracking operations contain relatively large proportions of extremely light hydrocarbons as is evidenced by their unduly large Engler distillation losses and low Engler initial boiling points. Such gasolines will find disfavor with the motoring public due to vapor locking troubles and make it difficult for automotive designers to adapt gasoline feed systems to the conventional Engler 90 per cent. point. The development of vapor phase cracking will also enlarge the supply of liquefied petroleum gases, since one of the pressing problems in this field is the disposition of the large proportion of uncondensed vapors produced.

From the foregoing it is obvious that the supply of liquefied petroleum gas is adequate for the development of large markets. As the present resources of the natural gasoline industry are utilized, further reserves in the natural gas can be called into the markets. Refinery vapors can also furnish their share toward satisfying such markets as are developed.

A brief review of the economic history of the natural gasoline industry will serve to show the reasons why the development of markets for liquefied petroleum gas is being undertaken principally by this branch of the oil industry. The past history of the natural gasoline industry can be divided roughly into two parts.

During the earlier period, cheap blending material was available which permitted blending at gasoline plants. Under these conditions very volatile condensates were included in the finished blends. Practically all the butane extracted and, it is safe to say, large proportions of the propane removed from the natural gas were sold as a part of motor fuels. Frequently the manufacturer made more profit by selling low priced naphtha at high motor fuel prices than in operating his gasoline plant. There was little market for natural gasoline as such, and the manufacturer sold the finished blends in competition with the refiners, who sold him the blending materials. There were no definite specifications for natural gasoline and very little attention to a definition for good motor fuels.

CONDITIONS FAVORABLE

Due to the increasing demand for gasoline, the cost of naphtha for natural gasoline plant blending finally increased to prohibitive levels. This change marked the beginning of a new period. Events which followed or accompanied this economic transition were the establishment of definite specifications for motor gasoline and the rapid development of the oil absorption process. Eventually natural gasoline became a distinct commodity, bought and sold under standard specifications. The principal purchaser of natural gasoline became the

refinery and the product had to be shipped unblended. Obviously there was established a much lower limit to the proportions of butane and propane which finished natural gasoline could contain.

Thus we find conditions ideal for the development of new products and new markets. The natural gasoline industry has available large quantities of material, formerly marketed at a profit, which have been unnecessarily wasted for several years.

Diversification of markets should have a desirable effect in somewhat stabilizing the prices for natural gasoline. The price of U. S. motor fluctuates more than is desirable but the price obtained for natural gasoline varies even more. This is an unhealthy condition. In times of high prices the manufacturer is tempted to make expenditures not justified by average business conditions, while in times of low prices, he is compelled to economize beyond the limits of progressive policies.

Practically all the liquefied petroleum gas being marketed today is derived from natural gasoline itself. In other words, the liquefied petroleum gas components are separated from the natural gasoline condensate and marketed. The residual natural gasoline is a very stable product which can be marketed as aviation gasoline or as a superior motor gasoline. This practice will undoubtedly continue until an economic balance has been reached between the demand for liquefied petroleum gas as a component part of motor fuels and the demand for butane in the new markets.

In the meantime, liquefied petroleum gas will serve as a means of stabilizing natural gasoline markets, at the same time adding to the total revenue of the oil industry.

The relation of the liquefied petroleum gas industry to the refining industry is indeed a complicated one. The fact that refinery vapors are a source of liquefied petroleum gas and that the liquefied petroleum gas markets may materially aid in promoting the progress of vapor phase cracking have already been mentioned. On the other hand, liquefied petroleum gas in many of its uses is a direct competitor of fuel oil in industrial uses and of gasoline and kerosene in domestic uses. Furthermore, extended markets for liquefied petroleum gas will bring the refiner into competition with other purchasers for this portion of natural gasoline.

REFINERY VAPORS

In regard to refinery vapors as a source of liquefied petroleum gas, the following is an analysis of the uncondensed vapors at one refinery:

Methane and air	11.3
Methane and CO_2	7.4
Propane	28.5
Butane	31.7
Pentanes and heavier	21.1

The refinery in which these vapors were encountered produces a gasoline containing 1.1 per cent. propane and 5.5 per cent. butane on the liquid volume basis. The Engler distillation recovery of the gasoline produced runs as low as 95 per cent.

An investigation which included the composition analysis of more than 100 hundred filling station samples of commercial gasoline showed the results outlined in Table 2 in regard to propane and butane content of motor gasoline.

TABLE 2

Propane and Butanes Contents of Gasolines.
(Liquid Volume Per cent)

	Propane and Lighter	Butanes
Average of more than 100 filling station samples	0.4	4.0
Extreme maximums above samples	1.3	9.8
Estimated for natural gasoline	1.5	26.5
Estimated in average motor fuel, contributed by natural gasoline	0.2	2.7

Taking into consideration handling losses between the refinery and the motorist's tank, it is apparent that gasoline as derived from petroleum contains considerable proportions of propane and butanes.

Propane in commercial gasoline is not objectionable because it is a dissolved gas or because it raises the vapor pressure unless an excessive amount is present. In some instances, propane is desirable. For instance, propane improves the starting characteristics of gasoline particularly in cold weather. In addition a small amount of propane can have the same beneficial effect in this direction as somewhat larger amounts of butanes and considerably larger amounts of pentanes. The principal argument against the presence of propane in commercial gasoline is that by substituting equivalent proportions of butanes or pentanes for the propane, the starting and accelerating properties of the gasoline can be improved. This is precisely what the Natural Gasoline Association is stressing in its recently adopted motor fuel specifications. Here the emphasis is placed on pentane as the constituent imparting "pep" to motor fuel.

With cracking processes incorporating too much of the extremely light hydrocarbon material in finished gasoline and with vapor-lock a serious problem in gasoline consumption, it is reasonable to believe that refiners will eventually pay quite as much attention to the fractionation of the light end of their gasoline products as is now being paid to the fractionation of the heavy ends. Propane, butanes, pentanes, etc., will be added in controlled amounts so as to provide the best average motor fuel from the material available. The natural gasoline industry is rapidly putting its house in order for this development but the problem has received too little attention at refineries.

VALUE TO REFINERS

In regard to the uncondensable gas produced in vapor phase cracking and its relation to the liquefied petroleum gas industry reference is here made to Luis de Florez' talk delivered at this convention one year ago:

"The non-condensable gas produced by vapor phase cracking has a very high heat value as well as illuminating properties and is similar in almost all respects to the gas that is produced by gas companies to enrich water gas. It is conceivable, therefore, without much imagination, that gas companies would be willing to buy this gas from the refineries at a reasonable cost, instead

of purchasing gas oil which they, in turn, must process at considerable expense and plant investment, to serve the same purpose.

"It is further conceivable that refineries, which are situated within reasonable proximity to large centers of population, could afford to operate vapor phase plants, selling the gas as one of the resulting products to public utility companies, and actually make it a source of revenue. Possibly some desultory attempts have been made to work out arrangements of this character, but if only a portion of the effort which has been devoted to the sale of refined oil has been put on the sale of gaseous products, a ready market would doubtless exist for them today. Heretofore there has been little necessity to consider this problem seriously, due to the comparatively small amount of gas formed in existing liquid phase plants, and it is only natural that development should await the necessity. The only apparent obstacle to the profitable sale of gas appears to be the necessity of creating a true realization of its value."

It is evident that here is one branch of the refining industry that will work hand in hand with the natural gasoline industry in developing markets for liquefied petroleum gas.

However, these are possibilities for the future. Liquefied petroleum gas as a competitor of fuel oil and as a means of stabilizing natural gasoline markets are realities of the present. In addition liquefied petroleum gas as a domestic gas popularly known as "bottled gas" will undoubtedly encroach on the present markets for gasoline and kerosene used for this purpose.

As a competitor of fuel oil liquefied petroleum gas is already making a serious bid for that portion of the market applied to the more or less exact heating operations of industry. In many heating processes the direct heat of liquefied petroleum gas can be used where muffle type furnaces are necessary with fuel oil. Liquefied petroleum gas can be used very effectively as a substitute for gas oil in the enrichment of manufactured gas. Obviously the price basis on which liquefied petroleum gas can compete with gas and fuel oil depends entirely upon the advantages to be derived from the use of liquefied petroleum gas. As a general rule, the ease of control of combustion, the purity of the fuel, and the rapidity with which heating units are placed in operation are very decided selling points for liquefied petroleum gas. Off-setting these advantages are the increased cost of storage and the somewhat lower calorific value for liquefied petroleum gas.

IMPROVES MOTOR FUEL

Perhaps the most important aspect of the liquefied petroleum gas industry for the refiner is its influence on the natural gasoline market. Natural gasoline from which all the butane has been removed is an entirely different product from the customary commercial grades of natural gasoline. To begin with, it is an excellent aviation fuel, superior in many respects to the aviation fuel produced at refineries. This has been amply demonstrated by several natural gasoline manufacturers as a result of their own investigations and is being carefully studied by the Bureau of Standards and the S. A. E.

This aviation natural gasoline cannot be normally used as a fuel for automobiles, although it is an excellent winter gasoline. Slight changes in automotive design would enable its satisfactory use. However, relatively small proportions of refinery gasolines and naphthas are required in preparing superior motor fuels. It follows, therefore, that the natural gasoline industry is capable of finding direct markets for its products when the refinery market is unprofitable.

Provided markets can be created for butane, and there is every reason to believe the markets exist, the prices for natural gasoline are bound to be stabilized for several reasons. The butane markets will be competing for a portion of the natural gasoline. The supply of natural gasoline will be automatically reduced. The demand will be increased because larger proportions of the very stable gasoline will be required to impart the desired "pep" to finished motor fuels. The natural gasoline manufacturer will have a residual product with which he can go directly to the trade.

Many progressive companies are entering the liquefied petroleum gas industry. There are at least 20 different brands of "bottled gas." While many of these activities are in the very early stages of development, the liquefied petroleum gas industry is assuming commercial importance by leaps and bounds. It is estimated the 1928 sales of liquefied petroleum gas will exceed by 100 per cent. those of 1927 and that the volume of business in 1929 will be many times greater. In many fields doubting Thomasas have been converted to the use of liquefied petroleum gas and these leaders will undoubtedly be followed rapidly by others in the same fields. The initial resistance to a new thing has been largely overcome in certain applications.

At the present time the principal advantages of the liquefied petroleum gas industry accrue to the natural gasoline branch because a diversity of markets and a flexibility in sales programs are made possible. This trend toward stability for the natural gasoline industry will in itself be an advantage to the entire oil industry. Over and above this, markets new to the petroleum industry are being developed which will have the effect of increasing the total revenue. In addition, the refining industry may easily become a source of liquefied petroleum gas, with vapor phase cracking depending greatly upon the new markets.

Finally, no commentary on the liquefied petroleum gas industry would be complete without mentioning that here we find a true example of conservation of our natural resources. By applying the principles of modern engineering and merchandising the natural gasoline industry is finding it possible to divert a portion of natural gas from its customary low price field to markets where higher values prevail. History promises to repeat itself with liquefied petroleum gas playing the role formerly played by natural gasoline, in the oil industry's everlasting problem of providing civilization with the utmost convenience and utility from the resources available.

Utilization of Heavy Oil Acid Sludge

By HAROLD G. OSBORN and LLOYD L. DAVIS,
Marland Refining Company

ONE of the earliest and most persistent troubles of the petroleum refiner has been the utilization of the wastes or acid sludge resulting from the treatment of oils with sulphuric acid. In fact, in many plants today, the problem is one of disposal rather than utilization, the refiner being satisfied if he can get rid of the nuisance without any prospect of valuable return. Considerable[1] progress has been made in the recovery of acid and "fuel oil" from acid sludges produced in the treatment of light oils, "neutral" paraffin lubricants, and[2] naphthene base oils.

The producer of acid treated cylinder stock and bright stocks from dark or mixed base crude oils, has had a more difficult problem. This is due, first, to the fact that the sludge is produced in great quantities because of the large amount of acid used and the heavy treating losses incurred; and second, the character of the cylinder stock sludge makes it very difficult to handle in any type of separator yet developed.

During the past few years, several Mid-Continent refiners have developed methods for fluxing the acid sludge produced from the treatment of cylinder stock with various oils and chemical stabilizers, the resulting mixture being sufficiently fluid to be burned in special fuel oil systems. At best, however, such systems are far from satisfactory. The nuisance from the sludge pond is overcome, but the fluxed sludge is a poor fuel, being difficult to handle in the usual fuel oil systems and containing all the acid content of the sludge. In such systems the acid is wasted, and as weak acid can be concentrated to 61-63 gravity at a cost of less than $5.00 per ton, it will be seen that the separation of the acid from the sludge is a vitally important economic problem to to the cylinder stock refiner.

As mentioned above, acid sludge from cylinder stock is not easily separated in the ordinary type of "cooking" kettle. The sludge being heavier than water, sinks to the bottom and cannot be thoroughly agitated with the water. The water hydrolizes the sulfonates and removes the acid from the outer layer of the lumps of sludge, thus "coking" the surface. This prevents the water from coming in contact with interior of the sludge lump and very incomplete separation take place.

The recently reported[2] method of separating acid sludges under high temperatures and pressures cannot be used with cylinder stock sludges because under those conditions, the sludge is "coked" completely to a solid non-fusible mass heavier than the separated acid and cannot be drawn from the separator.

Our cylinder stock operation consists of treating approximately 2000 barrels raw stock daily. Thousand barrel agitators are used, the oil charge being 850 barrels. The amount of acid used depends upon the tar content of the raw oil and upon the color desired. This operation results in the daily production of approximately 100 tons of acid sludge, which is termed "green sludge" as it still contains sufficient oil to give it a green cast.

SEPARATION

The green sludge is separated in lead lined open cooking kettles. The success of our cylinder stock sludge separation depends, first upon the use of light oil acid sludge with water to give a weak acid of sufficient gravity to float the green sludge at the start of the separation; and, second, upon the use of sufficient acid oil from a previous treat, along with some fresh slop oil or gas oil, to extract the oil content of the sludge.

The light oil sludge is that resulting from the treating of Dubbs Pressure Distillate and is about 45 degrees Be. gravity (heavy) and contains about 58 per cent. sulphuric acid. The solvent oil used may be any oil having a gravity sufficiently high to obtain separation.

The steps in the separation of the cylinder stock sludge are:

First—120 barrels of acid oil or "Top" oil are left in the kettle from the previous run, to act as a solvent to thin the heavy green sludge as it is drawn into the kettle.

Second—Thirty-five barrels of light oil sludge are charged to the kettle.

Third—About 100 barrels of hot water are added, the quantity being sufficient to separate the light oil sludge into a weak acid of 24 Be. (heavy) gravity which is heavy enough to float the green sludge. This step completes the preparation of the kettle for the recepit of the green sludge. The preliminary steps require about one hour.

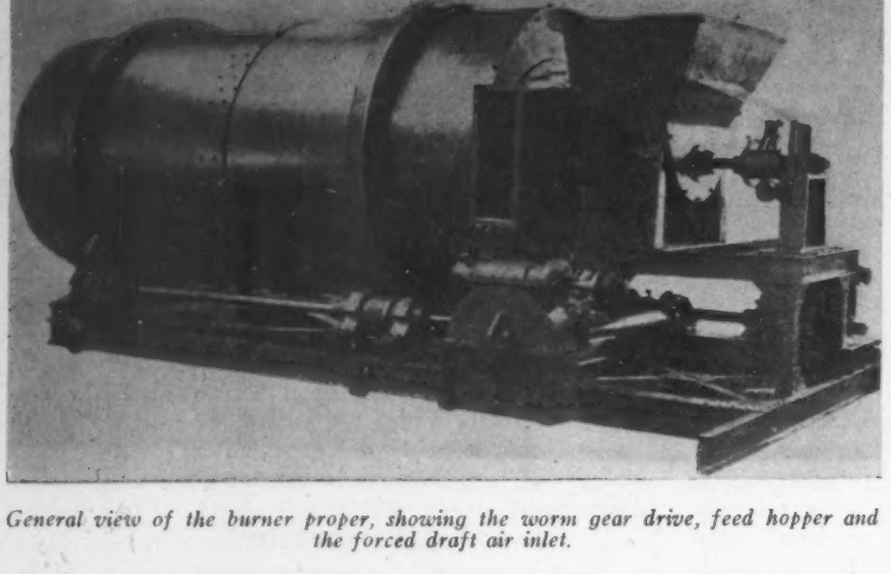
Fourth—The green sludge is then gravitated from the agitator into the kettle. A batch uses 235 barrels of sludge. The draw takes about two hours, and during this period, live steam is used in the kettle to agitate and heat the mass.

Fifth—About 175 barrels of solvent oil are then pumped in, about one hour being required.

Sixth—An additional 85 barrels of hot water are added over a period of one hour. During all of this time, the kettle is cooking with steam, the total cooking time being four to four and one-half hours.

Seventh—After the final water is added, the steam is cut off and the contents of the kettle allowed to settle

[1] A. P. I. Bulletin IX—7, Page 164, W. N. Davis.
[2] J. B. Rather—A. I. M. M. E.—Pet. Tech. in 1927—Page 554.



General view of the burner proper, showing the worm gear drive, feed hopper and the forced draft air inlet.

for three hours. Three layers are formed, a bottom layer of about 150 barrels of 24 degree Be. Acid, a middle layer of so-called "wet sludge" and a top layer of about 400 barrels of top oil. The acid layer is drawn off.

Eighth—The kettle is again cooked up with live steam, the contents being thoroughly agitated for ten minutes. The mass is allowed to settle for 1½ hours and a second acid draw is made, 70 to 90 barrels being obtained. If the separation is not good, several re-cookings may be necessary.

Ninth—With all the weak acid separated and drawn, the middle "wet sludge" layer is drawn to the acid pit where the remaining weak acid can drain off.

Tenth—About 285 barrels of top oil are pumped out, leaving 120 barrels in for the next run.

A typical run on a cylinder stock sludge kettle is outlined in Table No. 1 giving the actual acid and oil recovered.

TABLE NO. 1

Kettle No. 2 Batch No. 300

Charge	Bbls.	Gravity	Acid Content
Top Oil	120		
Light Oil Sludge	35	21.5 A.P.I.	
Green Sludge	230	50.1 Be.	12,60 lb.
Solvent Oil	175		19,849 lb.
Water	185		
Total Acid in Charge			32,309 lb.
Recovered			
1st Weak Acid	147	24.5 Be.	17,520 lb.
2nd Weak Acid	77	24.5 Be.	9,310 lb.
Total Acid Reclaimed			26,830 lb.
Per cent Acid Reclaimed			83%
Wet Sludge	111 (6.4% acid)		2,675 lb.
Fuel Oil	285	21.7 A.P.I	180 lb.
Top Oil (left in)	120	21.7 gr. A.P.I.	
Total Acid Accounted for			29,685 lb.
Per cent Acid Accounted for			92%

The weak acid is concentrated in a vacuum evaporator system, to 63-64 degrees Be. This is blended with purchased fuming acid (104% H_2SO_4) to make 93.5 per cent. acid.

The fuel oil or top oil, containing only 0.5 per cent. acid is burned in the regular pressure circulating fuel oil system, and presents no unusual difficulties if proper precautions are taken against corrosion.

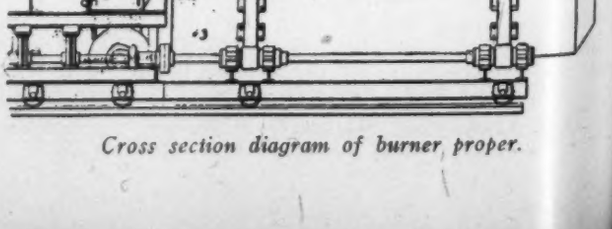
The wet sludge or acid "coke" as drawn from the kettle at 200 degrees F. is a plastic mass which can be handled readily while hot. At 150 degrees F. it sets to a solid, and after once cooling and setting does not soften on re-heating. It may contain as high as 40 per cent. water and acid, and varying amounts of oil, depending upon the completeness of the separation. A typical sample shows only 33 per cent. soluble in ether or benzol.

The wet sludge was formerly hauled to a sludge storage pond, but for the past four months has been burned at the boiler house in a Duncan Rotary Sludge Burner. This burner has successfully handled green sludge directly from the agitators, wet sludge from the cooking kettles, and dry sludge dug out of the old sludge pond.

The Duncan Rotary Burner[3] has been developed over the past two years by Mr. W. M. Duncan and is designed to handle any type of waste fuel from petroleum refineries, benzol plants or any similar industry. The first three burners developed were of 500, 1500 and 3000 pounds per hour capacity and were installed in refineries located in Illinois. During the early development period many mechanical and operating difficulties were encountered. These were largely in connection with the handling and feeding of the fuel and have been overcome. At the present time the burner may be considered a satisfactory commercial unit. During the past six months two Mid-Continent refiners have installed these burners for handling cylinder stock acid sludge. The first burner installed at Ponca City was designed for 4000 pounds wet sludge per hour and has easily handled half our production of wet sludge. A second burner is now being installed to handle the remainder of our current production.

DESCRIPTION OF BURNER

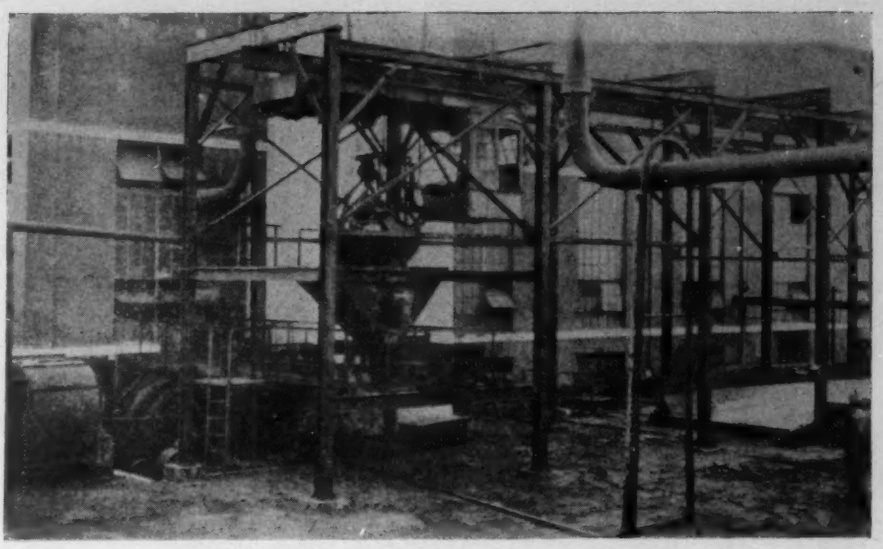
The rotary sludge burner proper, as shown in the illustrations, is basically a small rotary kiln, mounted in a horizontal position and rotated by means of a motor



Cross section diagram of burner proper.

[3] L. L. Davis—A. I. M. M. E.—Pet. Tech. In 1927—Page 564.

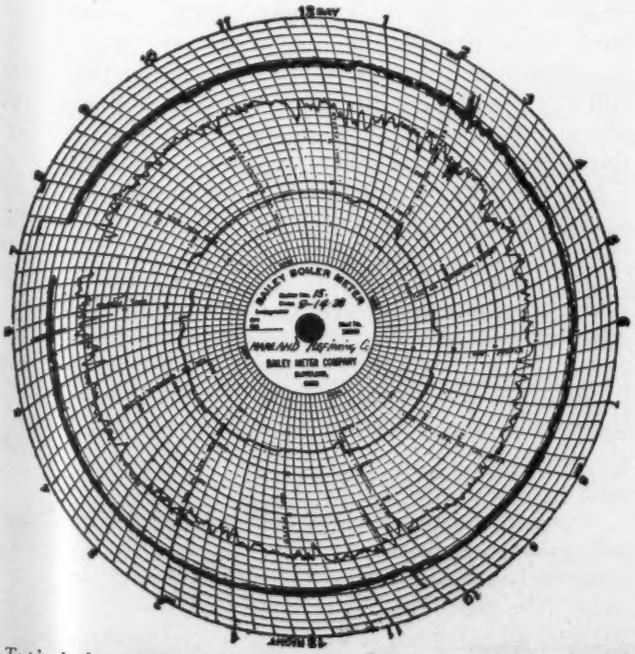
drive through two pairs of trunnions. The burner in question, designed to burn 4000 pounds of wet sludge hourly, has a half-inch thick steel shell 6 feet in diameter and 15 feet long. The shell is lined with 6 inches of cupola fire brick throughout. The speed of rotation is 20 revolutions per hour. The rear end is equipped with a fuel hopper and a variable speed screw conveyor, which feeds the fuel into the kiln at the desired rate. The shaft of the screw is hollow and functions as a fuel gas burner, for preheating the kiln and to insure immediate ignition of the heavy fuel. The forward end of the burner is restricted in size to hold the solid fuel in the kiln until entirely consumed. All parts of the burner coming in contact with the acid fuel, such as the hopper and screw conveyor, are made of a special cast iron to withstand the corrosion of the weak acid carried with the sludge.



General view of sludge handling equipment, showing the monorail crane, clam-shell bucket, storage hopper and drag chain conveyor.

The fuel may be solid, plastic, semi-fluid, liquid or any mixture. It is fed through the screw conveyor and falls onto the incandescent fuel bed or burner lining where it almost instantly ignites. The volatile portions are vaporized and burned as gases and vapors in the early part of the cycle, and the residue is coked. The rotation of the burner keeps the fuel mass agitated, continually bringing fresh fuel against the heated lining where it is cracked to gas and coke.

When burning plastic or semi-fluid material, the fuel softens and tends to remain in mass on the bottom of the burner. High pressure jets of air or steam are directed against the plastic mass to agitate it until such time as the fuel is cracked to gas and coke by the heat of the kiln walls. Experience has shown that steam functions equally as well as compressed air for this purpose.



Typical chart from Bailey Boiler Meter from boiler fired with wet sludge. The inner line shows the flue gas temperatures; the second line gives the rating on the boiler in per cent., and the third, or outer line, represents the air flow and reads in per cent. The sharp surges at 2 P. M., 10 P. M. and 6 A. M. were caused by blowing soot.

Air from a forced draft fan is admitted around the screw conveyor, and passes through a series of vanes which give it a rotary motion. This causes the air to hug the inside of the burner in such a way as to be brought in close contact with the fuel bed and any liquid fuel which may be carried up on the sides of the burner. The air admitted to the upper part of the burner supports the combustion of the gases. Tuyeres located below the fuel line furnish air for the combustion of the solids.

The rotation of the burner rolls the fuel mass over and over, advances it towards the front of the burner and breaks up the coke. The forced draft picks up the small coke particles and ash and carries them into the boiler combustion space.

Sufficient primary air may be used to practically complete the combustion, or if preferred, the burner can be operated as a gas producer and secondary air used in the furnace proper to complete the combustion.

The wet sludge is picked up from the storage pit by means of a monorail crane and clam-shell bucket, and is charged into a storage hopper located directly behind the burner. A variable speed, cast iron drag chain conveyor breaks the sludge into small lumps and conveys it from the storage hopper to the small feed hopper on the burner proper. The conveyor is controlled by a variable speed motor at such a rate as to keep the feed hopper about half full of fuel. The sludge is charged from the feed hopper into the burner by means of the screw conveyor at such a rate as is required to hold the desired rating. Sufficient gas is burned at all times to insure ignition of the heavy fuel. This usually requires about 6000 cubic feet per hour.

OPERATION OF BURNER

The 4000 pound per hour burner is installed on a 550 horsepower boiler and no difficulty is encountered in carrying a 200 per cent. rating. Due to the non-uniformity of the fuel, it is somewhat difficult to maintain close regulation on the boiler, but this irregularity is

TABLE NO 2.

Summary of Two 24-Hour Test Runs

	Separated Sludge from Kettle	Green Sludge from Agitator
Size of Burner	6′ x 15′	6′ x 15′
Boiler—550 h.p.		
	Separated Sludge from Kettle	Green Sludge from Agitator
Average total rating	203%	199%
Rating due to gas pilot	39	40
Net rating due to sludge	164	159
Pounds steam from sludge per day	673,607	653,070
Net Btu/lb. team	1,067	1,067
M Btu in steam from sludge/day	718,739	693,560
Btu per lb. dry sludge	12,500	13,000
Pounds dry sludge per day	82,000	74,600
Evaporation per lb. dry sludge	8.2 lb.	8.7 lb.
M Btu from sludge	1,025,000	969,800
Per cent Efficiency	70.2%	71.6%
Tons dry sludge burned per day	41.0	37.3
% Water and acid in sludge	40%	20%
day	68.3	46.6
Pounds wet sludge burned per hour	5,692	3,884
Flue Gas temperature	587°F.	570°F.
CO_2	11.0%	10.5%
O_2	6.3	7.0
% Air	140	144
Air Temp.	90	90
Furnace draft	0.09	0.09
% Hydrogen in fuel	8%	10%
Pilot flame gas cu. ft/hr.	6,660	6,720
Btu per lb. gas	21,000	21,000
Btu per lb. combined fuel	14,200	14,600
Lb. air per lb. fuel	13.00	13.00
Lb. dry flue gas formed per lb. fuel	13.28	13.1
Total dry flue gas per lb. fuel	18.48	18.8
Lb. water formed per lb. fuel	72	0.9
Total wet flue gas per lb. fuel	1.12	1.1
	Btu = %	Btu = %
Btu per lb. combined fuel	14,200 = 100	14,600 = 100
Btu loss in Dry Flue gas	2,210 = 15.6	2,160 = 14.8
Btu loss in wet flue gas	1,420 = 10.0	1,390 = 9.5
Btu loss radiation and miscellaneous	500 = 4.2	500 = 4.1
Btu to steam = eff.	9,970 = 70.2	10,450 = 71.6

easily taken care of by the other gas or oil fired boilers. Considering the poor quality of the fuel and its nonuniformity surprisingly good combustion is obtained. When burning dry, hard sludge from the storage pond, practically no smoke is produced, but when burning wet or "green" sludge, a slight smoke haze is visible.

The reproduction of a typical day's chart from the Bailey Boiler meter shows the regulation obtained. The inner line records the flue gas temperature, showing a variation of from 540 to 580 degrees F. The middle line charts the steam production in terms of "per cent. of rating" and varies on an average of from 190 to 210 per cent. The sharp momentary fluctuations occurring at eight-hour intervals on these charts were caused by blowing soot. The outer curve is the "air flow" which is read on the per cent rating scale and from which is calculated the per cent. of excess air, in this case averaging 44 per cent.

The results of two 24-hour test runs are shown in Table 2. The first run was made on separated "coke" direct from the cooking kettles, while the second run was made on "green" sludge from the agitator.

The past four month's operation has served to bring out the weak points in the design and construction of the present burner and may be used as a basis to forecast future performance. The most serious trouble which has developed is the question of the corrosion of the feeding mechanism by the weak acid. The screw conveyor was attacked very rapidly and this has been minimized by greatly increasing the thickness of the cast iron vanes on the conveyor and re-designing the equipment to permit rapid and easy replacement of the parts. The best solution to this problem is the thorough drainage of all weak acid from the sludge before burning.

Some trouble was had with the front wall of the boiler against which the flame from the burner played. The very high temeperature and velocity of the flame quickly fluxed the front wall in which a standby gas burner was installed. This difficulty was overcome by reconstructing the wall with high temperature brick and building the gas burner of tile in such a way as to permit the burner tips being withdrawn from the setting when not in use. This experience has shown that a very high setting, at least 18 ft. for this size boiler, or a large dutch oven is desirable for a burner of this type.

One operating difficulty is worth mentioning and that is the building up of a solid coke ring inside the burner which prevented the proper feeding and burning of the fuel. This was found to be caused by an improper ratio of fuel rate, pilot flame gas and agitating steam; when these conditions are right, no coke rings are formed.

CONCLUSION

A satisfactory method is outlined for the profitable utilization of cylinder stock acid sludge. The sludge is separated into weak acid, fuel oil and solid sludge or coke. The weak acid is concentrated for re-use while the fuel oil is burned in an ordinary fuel system.

The new Duncan Rotary sludge burner is described, which will successfully handle a wide variety of waste materials which have heretofore been a total loss to the refiner.

The Carter Oil Company's Grisso No. 1 Air Plant, operating 12—165 H. P. Bessemer Type Ten Compressors equipped with 13½"x6¼"x20" Bessemer V. H. Cylinders

Why do Bessemers dominate in Compressor service?

BECAUSE of their unfailing high running time—Bessemers invariably deliver 99%+ running time.

Because they are specifically engineered for Oil Industry compressor service—Bessemers are unsurpassed in both compressor and mechanical efficiency.

Because they require less servicing—Bessemers literally run themselves, and require the very minimum of parts adjustment or replacement.

Because their economy is something tangible—for years Bessemers have been demonstrating in thousands of installations that their operating cost per hour of service is appreciably lower.

Because Bessemers have every sound, advanced feature known to engineering science—and are built with strength plus to deliver service plus.

These are just a partial list of the reasons why more compressor plants are powered with Bessemers than any other make.

BESSEMER ENGINE COMPANY
18 York Street :: Grove City, Pa.

BESSEMER

California Association Sets Pace on West Coast

Fall meeting reveals growth and shows natural gasoline industry to be in favorable position

By BRAD MILLS
Staff Representative

LOS ANGELES.—The second fall meeting of the California Natural Gasoline Association was held here November 13 and 14, with more than 500 members and visitors in attendance. All sessions were held in the Biltmore Hotel.

George L. Ratcliffe, president of the organization, called the meeting to order and delivered a welcome address which was also an accurate review of the association's accomplishments during the year and a report of the industry in California. He showed how the membership had increased from 250 to 600 members during the year and how the association has fostered experiments which had led to recognition by many of the leading companies. Many of the larger companies have adopted as standard some of the tests worked out by the organization, particularly the "Tentative Standard Procedure for Making the 30-32° Pressure Charcoal Test for Gasoline Content," which was published in bulletin form and distributed to the leading companies.

It was shown by Mr. Ratcliffe that the California Natural Gasoline Association is filling a need in California, where natural gasoline plays an important part in the total gasoline produced.

In reviewing the developments of the year in California, Mr. Ratcliffe pointed out that conditions have not materially changed. Present production of natural gasoline in the state is 1,700,000 gallons. The Buckbee zone in the Santa Fe Springs field is expected to increase this total to 2,000,000 gallons daily. Total storage of natural gasoline in California is now 56,000,000 barrels or about two months supply, it was stated. There is still an over-production in California, but it is no greater than at the same time last year, although production has increased about 50 per cent.

In combatting the present overproduction, it was suggested that the natural gasoline manufacturer give the refiner the best possible product to create a better market for the surplus gasoline. The production of natural gasoline in California is directly proportional to the production of light oil. Production is averaging 3.8 gallons per barrel of light oil, it was shown. Mr. Ratcliffe stated that overproduction undoubtedly would continue but that the industry looked prosperous for another year. He said that "Old Man Law-of-Supply-and-Demand" would take a hand and correct the situation in time.

Mr. Ratcliffe emphasized the fact that both producers and purchasers would fare better if sales contracts were made for only one year, instead of several years. He said that constantly changing conditions nearly always placed one or the other at a disadvantage before the period covered by the contract expired. An increased cost of production hindered the producer of natural gasoline, while an over-supply caused the purchaser to pay above current prices during the long contract period; it was shown.

By determining what product or products must be made to enable the refiner to best utilize the maximum quantity, to operate plants to make such products, and to develop markets and special uses for such hydrocarbons as cannot be include in natural gasoline, it would be possible to improve the industry during the coming year, Mr. Radcliffe stated. He explained that intelligence and hard work were the only definable pre-requisites for success.

The only paper read during the morning session, November 13, was "Use of Gas and Gasoline Analysis in the Practical Operation of a Natural Gasoline Plant," which was prepared in conjunction with the Gas Analysis Committee of the Association and presented by W. J. Podbielniak, research chemical engineer.

The paper dealt with the compositions of natural gas and gave references to a number of publications pertaining to gasoline plant work. The bibliography presented was quite complete covering an extensive range. Methods of fundamental analysis of natural gas and gasoline were described. The attention was called to the necessity of accuracy in sampling the gas and gasoline for analysis. The application of the results of the analysis were given, showing the possibility of making use of gas analysis for plant survey. The results of several plant surveys and two surveys of gasoline stabilizers were also given, the results showing quite conclusively the necessity of gasoline analysis for checking the operation of the gasoline stabilizer. Some very interesting charts were shown, giving the changes in compositions of gasolines when weathered at constant pressure.

To summarize the discussion in this paper, it was shown that fundamental analysis of natural gas and gasoline may be used for the accurate and absolute determination of potential production of products from a wet gas to determine plant and equipment efficiency, and to analyze plant performance. It is possible and desirable when using fundamental analysis to make close material balances for the individual hydrocarbons entering and leaving equipment or plant in order to determine the dependability and accuracy of the test and to trace the errors involved in the test, it was shown. Applications of fundamental analysis to plant and equipment surveys and to various calculations made possible by it were presented. The further application of both fundamental analysis and calculation of composition changes was advised.

The discussion, following the reading of this paper, was led by P. S. Magruder of the General Petroleum Corporation.

The first paper read during the afternoon session was "The Determination of the Vapor Pressure of Natural Gasoline." It was prepared by the Vapor Pressure Committee of the association and presented by H. N. Wade of the J. A. Campbell Company.

The purpose of the paper was to describe some of the experimental work which had been done on vapor pressures by several member companies during the past year, and to indicate the lines along which such work is now progressing.

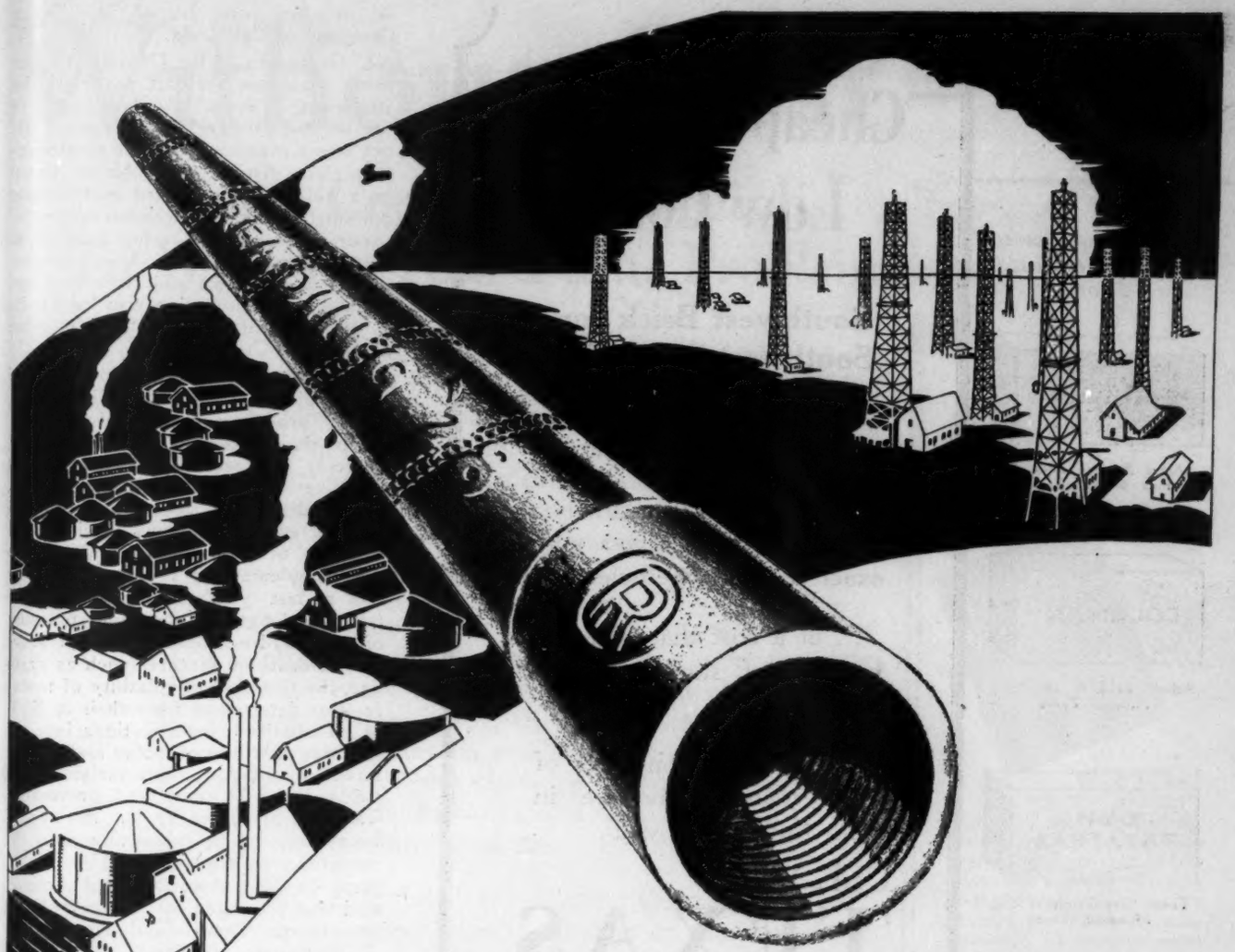
Two methods have been used as absolute checks against various types of practical vapor pressure testing instruments: namely, computation from careful analysis, and comparison with a very large bomb with a very small vapor space. Fairly good agreement is found between two new methods and these absolute standards, it was shown.

A short description was given of three commonly used methods, and certain weaknesses of these methods was discussed. The two new methods were described in detail.

The results of a large number of comparative tests between the three existing methods an the two new ones were presented, and the differences between them discussed.

The work done to date indicates that a more generally satisfactory method of measuring vapor pressure may be developed along the lines of the ideas embodied in the two new instruments described, it was shown in conclusion.

The general discussion was led by



"Yesterday" *and* "Tomorrow" Are the Same With *Puddled* Wrought Iron Pipe

BECAUSE Reading *kneads* fiery hot pure iron in the furnace, the high quality of Reading Pipe is assured through endless tomorrows—just as it has endured for countless yesterdays.

Kneading in the furnace is the time-tested way of making sure that each fiber of Reading Pipe gets a coating of rust-proof silicious slag—that the pipe will have the rope-like structure that ignores vibration and strain.

Reading *Puddled* Wrought Iron Pipe has been proved worthy by generations of use. Insist on the genuine—and look for the Reading name and spiral knurl mark on every piece.

READING PIPE

GENUINE PUDDLED WROUGHT IRON

READING IRON COMPANY, Reading, Pennsylvania

Atlanta Baltimore Boston Buffalo Chicago Cincinnati Detroit Houston Los Angeles New York Pittsburgh Cleveland St. Louis Tulsa San Francisco Fort Worth Seattle Philadelphia

Mention Where You Saw the Advertisement

Address Inquiries to Any Member Listed Below

Acme Brick Company, Fort Worth, Texas

Athens Brick & Tile Co., Athens, Texas

Texas Clay Products Co., Malakoff, Texas

Elgin Butler Brick Co., Austin, Texas

Cheap Freight! Low Cost!

Southwest Brick for Southwest Refineries

. . . a type of fire brick for each need.

. . . a type that gives you exact refractory efficiency.

. . . at a cost that is lower because of shorter freight hauls.

. . . all the economies of local manufacture are in your favor when you

USE

TEXAS FIRE BRICK

Consult any member on your requirements. Prices, suggestions, recommendations, etc., on request.

Texas Fire Brick Mfrs. Assn.
Promoting
Texas Fire Brick Economies

COLOR

YOUR HIGH COMPRESSION

GASOLINE

A DISTINCTIVE COLOR

Write us for samples of colors you wish to try

INTERSTATE COLOR CO., Inc.

41 PARK ROW NEW YORK

W. W. Robinson, Jr., of The Texas Company of California.

E. G. Ragatz, of the Union Oil Company, presented the last paper of the afternoon, "Some Fundamentals of Steam Still Design." Mr. Ragatz's paper was a graphical analysis of absorption plant distillation problems, based on a well known standard analysis and modified to take into consideration the vapor pressure relationship existing in actual plant practice. A number of curves were shown and their uses described. The discussion was led by H. J. Maxwell, of the Standard Gasoline Company.

The entire second day,—November 14—was given over to Dr. George G. Brown, professor of chemical engineering of the University of Michigan and Director of Research for the Natural Gasoline Association of America. Dr. Brown discussed "Motor Performance as Affected by the Lower Boiling Constituents of Motor Fuel," the discussion supplementing the one given by him at last year's fall meeting. He talked at length on the vapor pressure of pure hydrocarbons, vapor pressure of hydrocarbon mixtures such as gasoline, the equilibrium volatility of motor fuels as determined from their A. S. T. M. distillations, investigations into the effective volatility of motor fuels of different distillation characteristics, and vapor lock—its cause and prevention. The data presented by Dr. Brown had been gathered in connection with the research program sponsored by the Natural Gasoline Association of America and was presented by courtesy of that association. The discussion was led by E. G. Ragatz.

A banquet and entertainment was given during the evening of November 14 and was attended by 600 members and guests.

The Cushing, Oklahoma, refinery of the Empire Refining Company, in November, completed an entire year during which no accidents of any kind occurred. This is an outstanding record among refiners and this safety record was made possible through full cooperation betwen refinery executives of the company and the personnel of the plant. The safety program has been actively stressed at all Empire refineries during the last few years, and included in the safety work is the plant safety council, composed of refinery employees, which meets regularly each week to discuss possible hazards and to propose improvements in conditions where necessary. The Cushing refinery has carried off the honors during the last year in the safety contests participated in by the other Empire refineries at Gainesville, Texas, Okmulgee and Ponca City, Oklahoma, and the large silver cup won last year by the Ponca City plant, now has returned to Cushing. The other refineries, however, have set records in safety work that would also have won contests in anything but a no-accident year such experienced by the Cushing plant personnel.

Without Cost—

Put a Cook Paint Specialist To Work on Your Paint Problems

LARGE corporations frequently face what would seem to be a difficult problem in maintaining *uniformity* in painting—uniformity in color, uniformity in quality, uniformity in selection of the right paint for each different surface. Plant managers scattered in many territories frequently are tempted to let their individual preferences interfere with the maintenance of desirable uniformity.

Cook's Standardization Service successfully solves this problem. Our experts help you choose the right paint for every use; they work out a shop practice adapted to your needs; they show you how to save money, produce better results and reduce your upkeep costs. And for the guidance of your managers, we supply a Standardization Color Card made up exclusively for your individual use.

This Color Card assures the right paint for each surface about your plants, not only on the first order but on every subsequent order—whether it is large or small. The Color Card makes ordering easy, as shown by the color and number on the Card. The foreman or the purchasing department simply orders by number the paint, varnish, stain, enamel or lacquer indicated for the purpose desired. The Color Card thus becomes your paint "authority"—saving time, money, and cost of supervision.

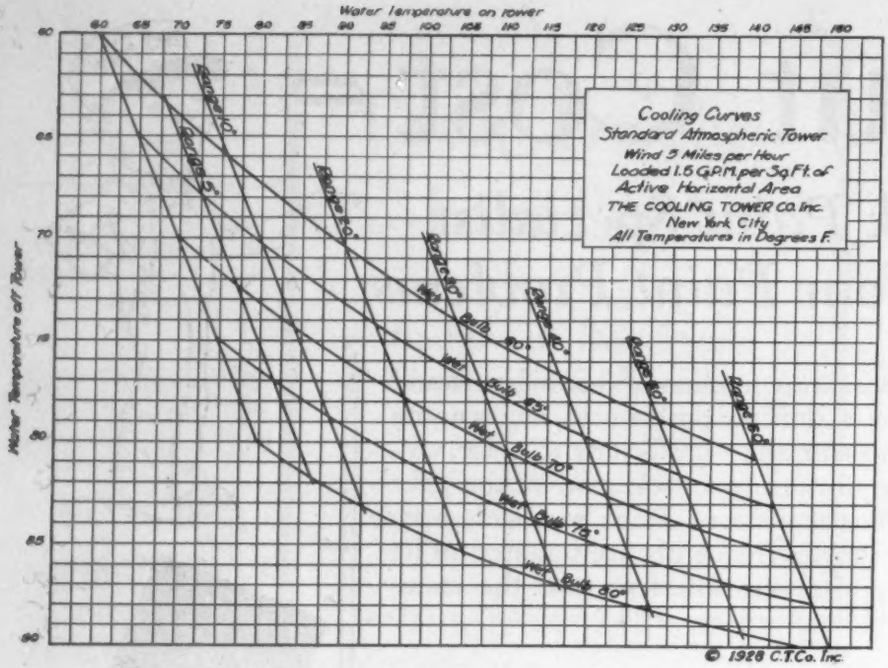
For further information, address Cook Paint and Varnish Company. Factories in Kansas City, St. Louis, Fort Worth, Houston, Cincinnati. Branches in the Principal Cities, including Tulsa, Oklahoma City, Amarillo, Dallas, Wichita, Denver, Omaha, Lincoln.

FREE!

Refinery superintendents, paint foremen, purchasing agents and general executives will welcome this new book by Cook—"Cook's Paints for Plant Maintenance." In non-technical language it describes the paint requirements for every kind of surface in industrial plants, metal, wood, brick, concrete, plaster, stucco. Specific recommendations and specifications are given for every painting problem. Color chips suggest a "standardization chart" for your plant. Copies of this handsome book are distributed on request only, to responsible executives.

COOK'S "ON THE AIR"

Tune in on WDAF, The Kansas City Star, Tuesday nights, 9:30 to 10 o'clock, Central Standard Time. Hear the Cook Painter Boys play your favorite melodies.



These Cooling Curves are Based on 20 Years of Experience

REGARDLESS of competitive cooling claims, the above curves are based on our 20 years of experience in the cooling tower field. They show you what results you can expect from properly designed atmospheric cooling towers, loaded 1½ gallons per minute per square foot of active horizontal area. A higher loading than this will result in poorer cooling results.

In many cases, a correctly designed cooling tower or a spray pond system will return its entire cost during the first year or two. With responsible firms we are ready and willing to enter into an agreement whereby the cost of the equipment is spread over one year or more, so that the payments can be made out of the savings effected. Our nearest representative will be very glad to explain this plan to you in detail.

THE COOLING TOWER COMPANY, INC.

15 John Street New York

Houston, Texas — The J. A. Rossiter Co., 410 Union Nat'l Bank Bldg.

Tulsa, Okla. — J. F. Pritchard & Co., 910 Mid-Continent Bldg.

Los Angeles, Calif. — N. O. Fleming Co., 5815 Maywood Ave., Huntingdon Park

Representatives in other Principal Cities

PARKER

Wherever men use pipe

PARKER TUBE COUPLINGS

are in demand and available in correct size, shape and metal.

THE PARKER APPLIANCE CO.

10320 BEREA ROAD, CLEVELAND, O.

U. S. A.

P-376

W. P. R. A. Plans Division of Research

The annual meeting of the Western Petroleum Refiners Association will be held at Saint Louis, March 12, with convention headquarters at Hotel Jefferson, it has been announced by Howard Bennette, managing director of the association. The one day session will be given over to the customary association business, but with work of the group concentrated on its reorganization plans and expansion of its program of influence this involves the formation of a new group, or division of member petroleum refiners operating in the north central states. Headquarters for this group will be at Chicago. Offices have been secured in the McCormick Building at 332 South Michigan Avenue. The association also plans formation of a research division or department; the work of this section will be outlined at the spring meeting.

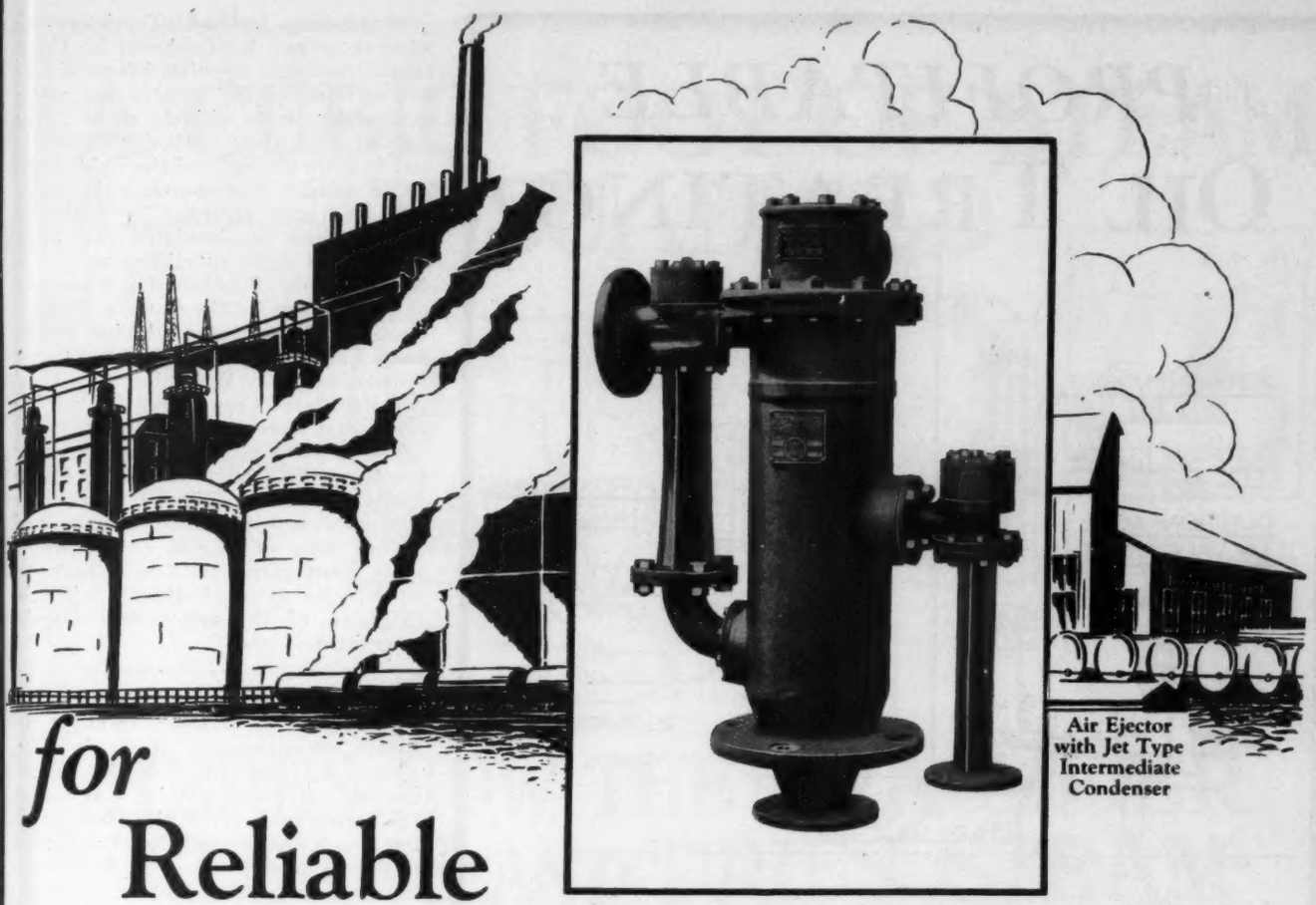
Howard Bennette, managing director of the association in connection with the foregoing announcement also stated that A. V. Borque who recently resigned as secretary and treasurer of the Natural Gasoline Association of America, will begin his new connection as assistant to the managing director of the W. P. R. A. on December 15.

Headquarters of the association are in the Cosden Building, Tulsa.

Discuss Method of Vapor Pressure Determination

During the convention of the American Petroleum Institute, a conference was held at the Stevens Hotel, Chicago, between representatives of the Bureau of Explosives, the California Natural Gasoline Association, the Natural Gasoline Association of America and the Vapor Pressure Committee of the American Petroleum Institute to discuss the proposal of the Bureau of Explosives that a change be made in the near future in the official method for determining the vapor pressure of gasoline. The Bureau is suggesting that the present empirical method be replaced by some method that will give substantially true vapor pressure. Two such methods are available: the Beistle and Frather method and the Reid method, the latter having already been adopted by the Natural Gasoline Association for specification purposes.

The representatives of the petroleum industry endorsed the substitution of the Reid method for the official method of the Bureau, provided that this change does not disturb, to any extent, present practices in the shipment of gasoline either in the ordinary or in the insulted tank car. This means that a change in the vapor pressure limit for both classes of cars must be made since the true vapor pressure of gasoline is quite different from that obtained through the use of the present Bureau



Air Ejector with Jet Type Intermediate Condenser

for

Reliable High Vacuum

WHERE reliability is essential--where continuity of service must be maintained--the Westinghouse high vacuum steam jet air ejector has proved an economical production agent. Its life is long, and its maintenance cost low. Today the superiority of this type of air pump is being established wherever high vacuum is employed.

Extreme simplicity characterizes the design and construction of the Westinghouse ejector. There are no complicated or moving parts to require adjustment or replacement. Continuous operation is assured under the most strenuous conditions. It requires little attention, no lubrication, and is notable for quick starting and noiseless operation.

Ask our nearest office for leaflet L-2042-C which explains in detail this ejector.

Power Plant Equipment Includes

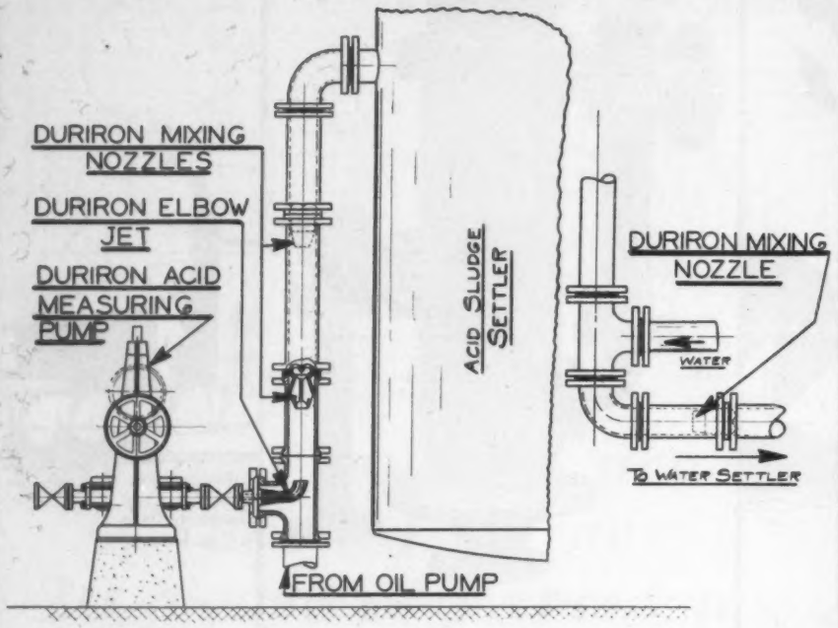
- Air Ejectors
- Feed Water Heaters
- Generators
- Generator Air Coolers
- Heat Exchanges
- Jet and Barometric Condensers
- Reduction Gears
- Surface Condensers and Auxiliaries
- Stokers
- Turbines

Westinghouse Electric & Manufacturing Company
South Philadelphia Works Philadelphia, Pa.
Sales Offices in all Principal Cities of the United States and Foreign Countries

Westinghouse

T 30099

PROFITABLE OIL TREATING



HERE is an efficient and flexible Duriron installation that is time saving and profitable for treating light oils.

The pump accurately measures the acid fed into the oil line by the elbow jet, just in front of the mixing nozzle.

Not more than two nozzles are required for thorough mixing, and they cut down treating time, eliminate back pressure, and insure an intimate mixture of oil and acid.

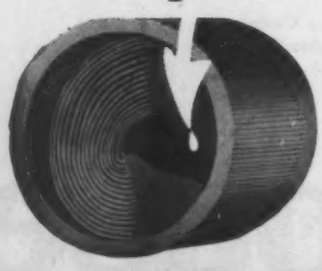
Acid-proof Duriron assures long time service.

Let us send complete information.

Duriron is produced only by

The DURIRON COMPANY
DAYTON·OHIO

The Spiral Motion Is the Trick



That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request

B. MIFFLIN HOOD CO., DAISY, TENN.

Mention Where You Saw the Advertisement

of Explosives method. To determine what these new limits should be, three committees were appointed from different sections of the country to make comparative tests with the present Bureau of Explosives method, the Beistle and Prather method and the Reid method on samples that approach the upper limit of vapor pressure for both the ordinary and the insulated car. The chairmen of these committees are: C. A. Neubaum, the Standard Oil Company of New Jersey for the Eastern district; G. G. Oberfell of the Phillips Petroleum Company for the Mid-Continent district; and P. S. Magruder of the General Petroleum Corporation for the Pacific Coast district.

The proposed change in the vapor pressure requirements of the Bureau of Explosives for the shipment of gasoline is of interest to the entire industry and anyone who desires to co-operate in these comparative tests have been invited to get in touch directly with the chairman of the appropriate district committee.

Following the resignation of Ira Cunningham, L. A. Webster, formerly assistant superintendent at the Wichita, Kansas, gasoline plant of the natural gasoline division, Empire Companies, has been transferred to the Thrall gasoline plant, Greenwood County, Kansas, as plant superintendent. L. A. Webster has been identified with the Empire Company for more than eight years, starting as a fireman at the Tallant plant in the late spring of 1922. Coincident with this change, Gordon Thomasson, who has been conducting special tests at the Tallant plant was transferred to Wichita, as assistant superintendent of plant operations.

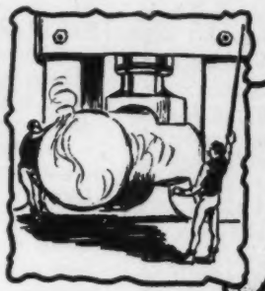
TWO TUBE STILL UNITS AT WEST TULSA

The Mid-Continent Petroleum Corporation has started construction work at its West Tulsa refinery, of two large tube still units. This marks the first of the new type of pipe still distillation units to be erected on this plant yard, as the company has heretofore done its skimming work in shell stills.

The units are to be somewhat larger of capacity than is generally installed, and it is reported that capacity rating will be 10,000 barrels each. The fractionating equipment is designed for the removal of a number of streams, and in addition to gasoline and kerosene, it is intended to take wax distillates, gas oil, from the tower and to produce long residuum and cylinder stocks continuously by pipe still distillation. The design of the units comes after two years of research work by the engineers of the Mid-Continent Petroleum Corporation, cooperating with the Foster-Wheeler Corporation, which has charge of the construction and installation. It is planned to have the new tube stills in operation in July of next year. Such units are in line with the modern trend of tube still installations in various other refining districts of this country.

A CUBIC FOOT OF STEAM VISUALIZED

Here's a cubic foot of steam from any good boiler.



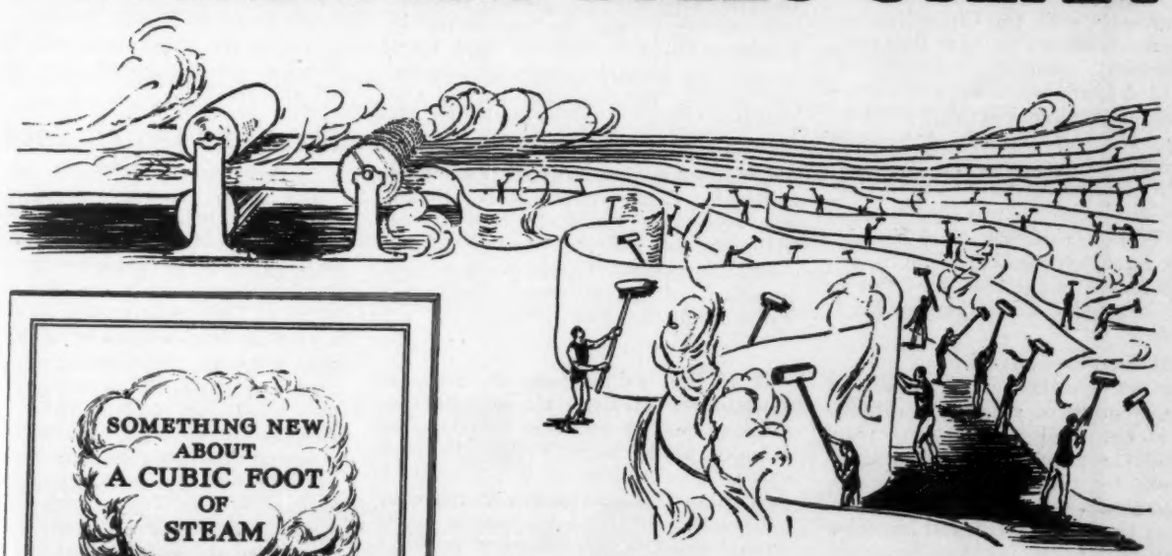
Round it out into a cylinder and drop it into a piece of 10" pipe.

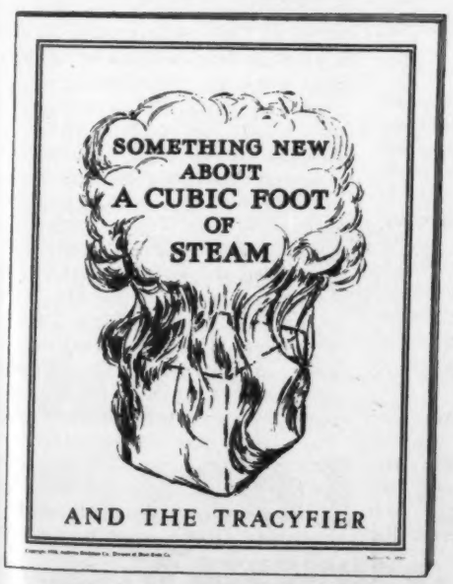
It will just fill 22 lineal inches of pipe.

But only 602 square inches of pipe metal touch steam.

If you want clean steam you must thin-slice the cylinder of steam and then clean *both* sides of *every slice*.

HERE'S HOW THE TRACYFIER CLEANS AND DRIES STEAM





IT'S INTERESTING
GET A COPY

The TRACYFIER cuts steam into hundreds of ribbons about 3/32 of an inch thick. Both sides of each ribbon are scrubbed many times as the ribbons move through the TRACYFIER. For each cubic foot of steam, 36,864 square inches of steam make steam-to-metal contact at least four times. In effect, 147,456 square inches of steam surface is scrubbed, thrown around sharp corners, expanded, contracted, stopped, rested, started again, scrubbed over and over. Then it is CLEAN and DRY.

ANDREWS-BRADSHAW CO.
DIVISION OF
BLAW-KNOX CO.
605 Farmers Bank Building PITTSBURGH, PA.

REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personnel Changes

RESEARCH AND DEVELOPMENT AT WHITE EAGLE REFINERY

White Eagle Oil & Refining Company, Kansas City, has recently created a new department in its organization which will be known as the Department of Research and Development. Headquarters offices of this branch is at its Augusta, Kansas, refinery. G. S. Dunham, formerly in charge of plant operations at the company's Fort Worth refinery was made superintendent of the new work. H. L. Bedell, who was chief chemist of the Augusta refinery, is director of research.

The former assistant superintendent of refinery operations at the Fort Worth plant, H. D. Van Deman, is now research engineer for the new department. H. K. Phillips, formerly assistant superintendent at the Augusta refinery was transferred to Fort Worth and made refinery superintendent, with E. G. Ritter, formerly of the engineering department, as assistant superintendent. Kenneth Swartwood is now chief engineer at the Fort Worth plant.

C. C. Durkee is now superintendent of the Augusta refinery with F. W. Stone, formerly with the Cities Service Oil Company refinery at East Baintree, Massachusetts, coming with White Eagle Oil & Refining Company as assistant superintendent. E. C. Forsythe, formerly of Fort Worth, has been transfered to Augusta as chief engineer, and A. B. Hunkerford returns as construction engineer.

R. C. French, formerly chief chemist of the Casper, Wyoming, plant is research engineer in the new department. He was succeeded at Casper by H. J. Holcomb.

One of the first endeavors of the department of research and engineering was the creation of a complete library which includes all of the latest and most important technical and engineering books by the leading authorities, to be used as reference by the personnel of the department and by other company employees interested in such phases of the manufacturing branch of the petroleum industry.

Globe Oil & Refining Company, operating the old Sinclair plant at Cushing, Oklahoma, which it has leased, is using West Texas crude which it receives through the Shell Pipe Line Company's line. The plant is skimming about 900 barrels of crude per day. The gasoline is delivered back to the Shell Petroleum Corporation by pipe line. Some of the zero cold pour test gas oil is also delivered by pipe; and the remainder of the gas oil and the zero pour test are sold in tank cars from the refinery. O. D. Gurley is refinery superintendent.

ALLEN REFINERY ENLARGED

White Oak Refining Company is concluding arrangements to increase the capacity of its refinery at Allen, Oklahoma, to 8000 barrels daily; and is installing a new battery of seven shell stills with complete Winkler-Koch towers.

The company has contracted for the following steel storage for crude oil: four 25,000-barrel tanks; two 10,000-barrel tanks; four 5000-barrel; four 2500-barrel; and six 1000-barrel tanks. The company recently purchased four 55,000-barrel tanks with 38 gravity Seminole crude oil from the J.A. Hull Company; and has closed contracts for a new six-inch line to run from Allen to the company property in Section 7-9-6, connecting with four 55,000-barrel tanks recently purchased from the J. A. Hull Company.

White Oak Refining Company now has capital stock of $325,000, the stockholders having declared a 100 per cent. stock dividend on November 20, and further increased capital by $125,000.

Construction work is now under way on one 1200-barrel Jenkins cracking unit, which should be completed by February 10, 1929; and one Gray treating tower with other necessary treating and storage are included in the program.

Directors of the White Oak Refining Company are: Victor H. Smith, president; Louis W. Pratt; B. E. Conner, secretary; Frank M. Sowle, vice-president of the Exchange National Bank, Tulsa; and Edgar Melitor, vice-president of the Hibernia Bank and Trust Company, New Orleans.

H. H. Redfield has been elected president of the McKean County Refining Company which operates a 1000-barrel refinery at Farmers Valley, Pennsylvania. The election of Mr. Redfield is part of the reorganization of the company which is to be completed at the annual stockholders meeting in January, 1929. Mr. Redfield has been identified with the production of petroleum in the Bradford field for a number of years. He will have active charge of the company's operations.

The Farmer's Valley refinery was designed by Earl Petty, now with the engineering firm of Smith & Leslie, Inc. The plant was built in 1926-27 and operated under the supervision of Mr. Petty until he resigned to go with the engineering company.

Mr. Redfield succeeds F. F. Moore, formerly president and general manager of the McKean County Refining Company. Practically all of the company stock is owned by producers of oil in the nearby Bradford field.

OHIO ENLARGING AND IMPROVING REFINING PLANTS

Ohio Oil Company is engaged in enlargement and improvement of various of its refining properties. At the Haynesville, Louisiana, field, it has combined its three small absorption plants into one plant of the absorption type with a capacity of 7700 gallons daily.

In the Salt Creek field it has increased the capacity of its plant from 8500 to 12,000 gallons daily. In the Bridgeport district of Illinois, its 21 small compression plants have a capacity of 6300 gallons daily. In the Casey division four plants have 1300 gallons daily capacity; and in the Robinson district 13 compression plants have 3300 gallons capacity. At Grass Creek, Wyoming, the company has a 6000-gallon compression plant, and at Lance Creek, Wyoming, a 5000-gallon plant.

Mid-Kansas Oil & Gas Company, a subsidiary of the Ohio Oil Company, has four absorption type gasoline plants, as follows: a 4500-gallon plant at Burbank, Oklahoma; a 7500-gallon plant at Eliasville, Texas; 1700-gallon plant at Desdemona, Texas; and a 6300-gallon plant at Caddo, Texas. The 50 plants of the Ohio, including these of Mid-Kansas, have rated capacity of 73,500 gallons daily.

TEXAS ENLARGING LOCKPORT PLANT

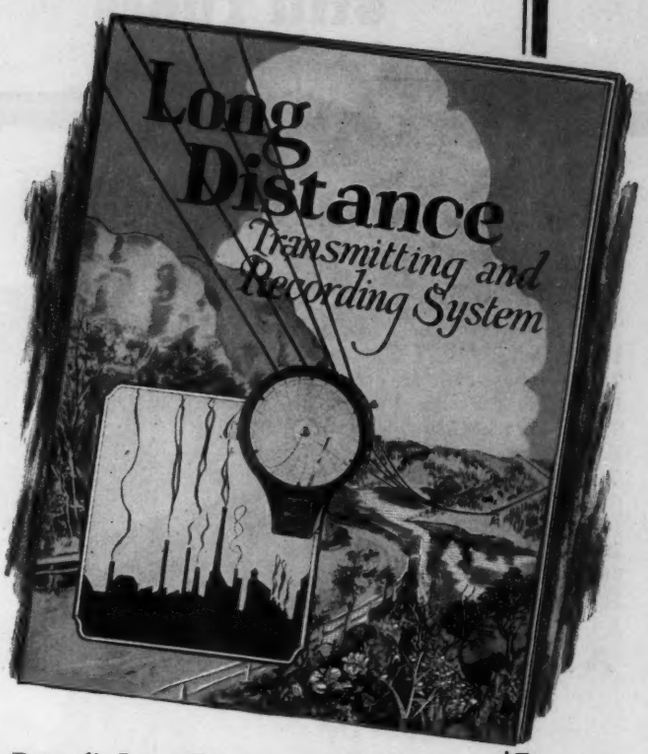
The daily capacity of The Texas Company's refinery at Lockport, Illinois, will be increased next spring from 6000 barrels, the capacity at which it has been operating since 1911, to 15,000 barrels. This enlargement of the refinery is in line with The Texas Company's plans to construct a 600-mile pipe line from Oklahoma and Kansas to Chicago on a 50-50 basis with the Empire Gas & Fuel Company.

For the purpose of building and operating this line, which will be of 12-inch pipe, The Texas Corporation and Empire Gas & Fuel Company jointly organized the Texas-Empire Pipe Line Company, with B. E. Hull, president of the Texas Pipe Line Company, as president. Prior to working out this joint arrangement, The Texas Company and Empire Gas & Fuel Company had each intended to build its own line over the same territory—The Texas Pipe Line Company an eight-inch and the Empire Pipe Line Company a 10-inch line. It was decided, however, that a joint project would be more economical.

The Empire Oil & Refining Company does not have a refinery in the Chicago district, but has announced the intention of building one there in 1929.

The Lockport refinery of The Texas Company heretofore has been obtaining

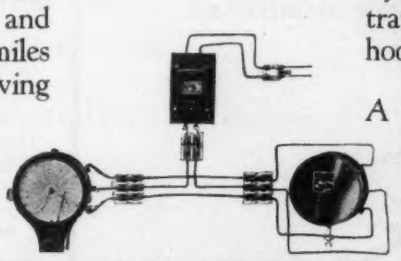
New Bristol's Catalog



Gives interesting story of How Long Distance System Centralizes Operating Information at the Point of Control.

THE full value of using Bristol's Long Distance Transmitting and Recording System is better realized when one considers the instant contact it gives with all parts of the plant or system. Very often it becomes vitally necessary to know what temperature or pressure is being maintained at some distant point, such as pipe lines; or at stills or coolers, etc., which may not be conveniently accessible by ordinary means.

In such instances a continual survey of existing conditions is provided by the Bristol's Long Distance System; the transmitting unit being installed at the source of pressure or temperature to be measured, and connected by means of three wires to a receiving recorder. This recorder can be mounted at any conveniently centralized point desired—at a distance of a few hundred feet away or even up to several miles—(successful installation has been made with transmitter and receiver eighteen miles apart). On the receiving instrument chart is recorded an exact duplication of conditions prevailing at the transmitter.



Diagramatic hookup of Bristol's Long Distance System for Pressure. Left: Indicating Transmitter; Right: Recording Receiver.

How Bristol's Long Distance equipment is being used to advantage in many industrial plants, utility systems, etc., is described fully in new catalog No. 1900, pictured above. Also included is complete listing of Indicating and Recording Instrument models which can be furnished—full size chart reproduction with actual records taken in field service—listing of charts in various ranges for use with Long Distance Systems — diagrams illustrating different methods of hook-up possible, etc., etc.

A copy of Catalog No. 1900 will be mailed to any interested person in your plant. Send us name and address .

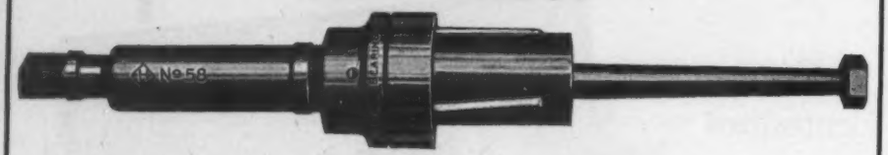
The Bristol Company

Waterbury, Connecticut

Branch Offices: San Francisco, Cal., 332 Rialto Bldg.

AKRON, DENVER, ST. LOUIS, CHICAGO, DETROIT, BIRMINGHAM, PITTSBURGH, PHILADELPHIA, NEW YORK, BOSTON

Heavy Duty Expanders for Still Tubes



Tools for the Oil Industries

Hydraulic Pressure Pumps, 8000 pounds
Tube Expanders for Cracking Still Tubes
Hydraulic Pressure Pumps, 2000 pounds.
Tube Expanders for Condenser Tubes
Hydraulic Pressure Pumps, 500 pounds.
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
Tube Expanders for Pipe Work
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches

A. L. HENDERER'S SONS
Wilmington, Del.
Established 1870
Expanders since 1884

THE R.S.C. SERVICE ACCURACY TULSA

Largest Scientific Material House in the Southwest, Including Complete Line of

TAG
Oil Testing Instruments, Etc.

HAYS
Gas Analyzers, Etc.

MERIAM
Manometers including Flow Meters, Etc.

The Refinery Supply Company
Tulsa, Oklahoma Dallas, Texas

its crude supply by tank car and through the line of the Prairie Pipe Line Company.

Preliminary engineering work on the new Texas-Empire line has been done, and the line is expected to be in operation by the middle of 1929. The initial capacity will be 36,000 barrels daily. Estimated cost of the line is $15,000,000.

The crude to be transported through the line will come largely from the Mid-Continent area, where both The Texas Company and the Empire Gas & Feul Company own and operate large oil gathering and transportation systems and where both companies are among the largest producers of oil.

TEXAS ENLARGING COLORADO REFINERY

The Texas Company will double the capacity of its refinery at Craig, Colorado, early in 1929, and will construct additional tankage for crude and refined oils. The company's refinery at Craig is operating on crude from the Moffat and Iles domes. It has capacity of 750 barrels per day, and is also equipped with Holmes-Manley cracking stills of 500 barrels daily capacity. The expansion of this plant is in line with the company's policy of building sufficient refining facilities near oil production centers to supply the surrounding territory with refined oils. Heretofore some of the production from the Moffat and Iles fields had to be shipped by tank car to The Texas Company's refinery at Casper, the Craig plant being unable to handle all the fields' production.

ALLEN PLANT ENLARGED

The plant of the White Oak Refining Company at Allen, Oklahoma, is being enlarged and will have daily capacity of 8000 barrels when all improvements are completed. The distillation equipment is being increased through the addition of seven shell stills. One Junkins cracking unit is being added and a Gray Process treating unit. Twenty storage tanks are being added for plant storage. A contract has been closed for the construction of a six-inch pipe line from the plant to a tank farm recently bought from the J. A. Hull Company in Section 7-9-6 of the Seminole City pool.

REFINERY RESUMES

Hutchinson Oil Refining Company's plant at Hutchinson, Kansas, is expected to be in operation late in November, with 1500 barrels daily capacity. The plant has been idle for several years. Additions to be made to the plant, to increase efficiency and capacity, include a Trumble cracking unit. The refinery will operate on crude produced near it.

W. R. Burroughs has been made superintendent of the International Refining Company plant at Sunburst, Montana, for The Texas Company. Mr. Burroughs has been with The Texas Company at Port Arthur for the last several months; previous to that he was located at the Casper, Wyoming, plant.

We offer

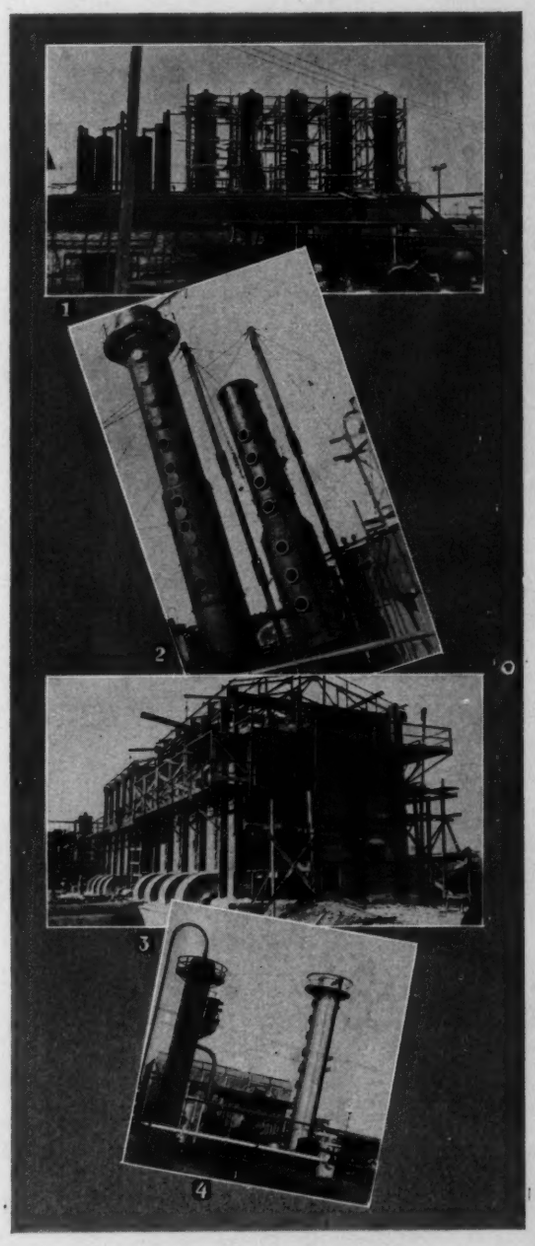
Experienced, Satisfactory Services to the Refiner

by furnishing

Estimates, Flow Sheets, Hook-Ups, Engineering Materials and Construction

in

1. **Remodeling Present Equipment.**
2. **Installing New Fractionating and Stripping Equipment.**
3. **Installing Tube Stills, Complete For All Services.**
4. **Installing Gasoline Recovery Plants.**



The WINKLER-KOCH ENGINEERING CO.

Consulting and Construction Engineers

429 FIRST NATIONAL BANK BLDG.

WICHITA KANSAS

TEXAS CONTROLS REFINERY IN CANADA

The Texas Company is now sole owner of the International Refinery Company plant at North Lethbridge, Alta., it has been officially announced. The International plant was owned by L. B. O'Neill and associates, including W. R. Wilson of Fernie, British Columbia. Mr. O'Neill sold his interests to the California Petroleum Company, which was later absorbed by The Texas Company, and the latter has now acquired the W. R. Wilson half-interest. The plant has not been in operation for some time, being used chiefly for oil storage.

WEST TEXAS REFINERY

The Amarillo Producers & Refiners Corporation, which maintains headquarters at Amarillo, Texas, will construct a 2500-barrel daily capacity skimming plant at Kermit, Texas, according to J. D. Wrather, president. This concern is operating a refinery at Borger, Texas, and also a 2500 barrels daily capacity skimming plant at Pyote. The latter plant is supplied with Hendrick field crude on contract by the Texon Oil & Land Company, crude deliveries being made direct to the plant via the latter's pipe line. John Wrather is superintendent of the Pyote plant, and also will have charge of construction work on the Kermit plant.

ROXANA NAME CHANGED

The Roxana Petroleum Corporation, a subsidiary of the English controlled Royal Dutch Shell interests, has changed its name to Shell Petroleum Corporation, without, however, making any change in organization or policy. This concern operates principally in Kansas, Oklahoma and Texas. The same interests operate on the Pacific Coast as the Shell Company of California.

VENEZUELAN REFINERY

Creole Petroleum Corporation, a subsidiary of Standard Oil Company of New Jersey, plans to build a 2000-barrel topping plant at its terminal on Paraguana Peninsula, Venezuela. It will supply fuel oil for the Lake Maracaibo fleet of shallow tankers operated by Creole Petroleum Corporation, and will supply part of the requirements of the Caribbean markets now served by the West Indian Oil Company, a marketing subsidiary of Standard of New Jersey.

CORAOPOLIS FIRE

A fire at the Coraopolis, Pennsylvania, plant of the Waverly Oil Works recently resulted in the destruction or damage of eight stills, several storage tanks, a machine shop, and a barrel house. The damage was around $100,000. The fire is believed to have been caused by sparks from a passing locomotive.

FAUGHT TO BIG SPRING

C. B. Faught, formerly superintendent of refinery operations at the Fort Worth refinery of the Texas Pacific Coal and Oil Company, has accepted the position of superintendent of the Richardson Refining Company's Big Spring, Texas, plant. Mr. Faught is well known in refining circles through his work in former connections and his contributions to the trade press. The Richardson Refining Company plant at Big Spring, which is now nearing completion, has a capacity of 5000 barrels daily. It is of the tube still and fractionating column type, and equipped with cracking units. It will operate on crude from the Roberts pool, in Howard County. It is located on a site adjacent to the new Cosden Company refinery of similar type now under construction.

FIRE KILLS TWO

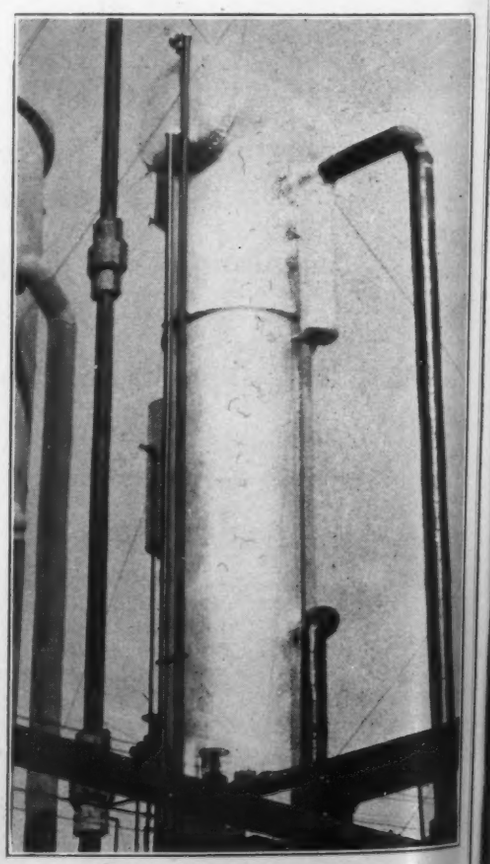
A fire at the Pyse, Kentucky, refinery of The Texas Company recently cost the lives of two employees, F. P. Prindle, power engineer, and Edward Tehan, chief chemist; and destroyed a portion of the research laboratory and auxiliary equipment. The two men were caught on the second floor of a three-story building in which they were carrying on experiments, the fire having started on the first floor, completely destroying the building. Damages were estimated at $100,000.

You Can Depend On It!

When your problem is a question of greater extraction; when flexibility and lower operating costs are important; you will find the solution in

ERECO DUPLEX
NATURAL GASOLINE PLANT EQUIPMENT

Designed and built by an organization that has for years specialized in the analysis of natural gasoline problems and successful production methods. Write us.



ENGINEERING, RESEARCH & EQUIPMENT CO.

Consulting, Research, Design, Manufacturing, Construction
Absorption Plant and Refinery Equipment

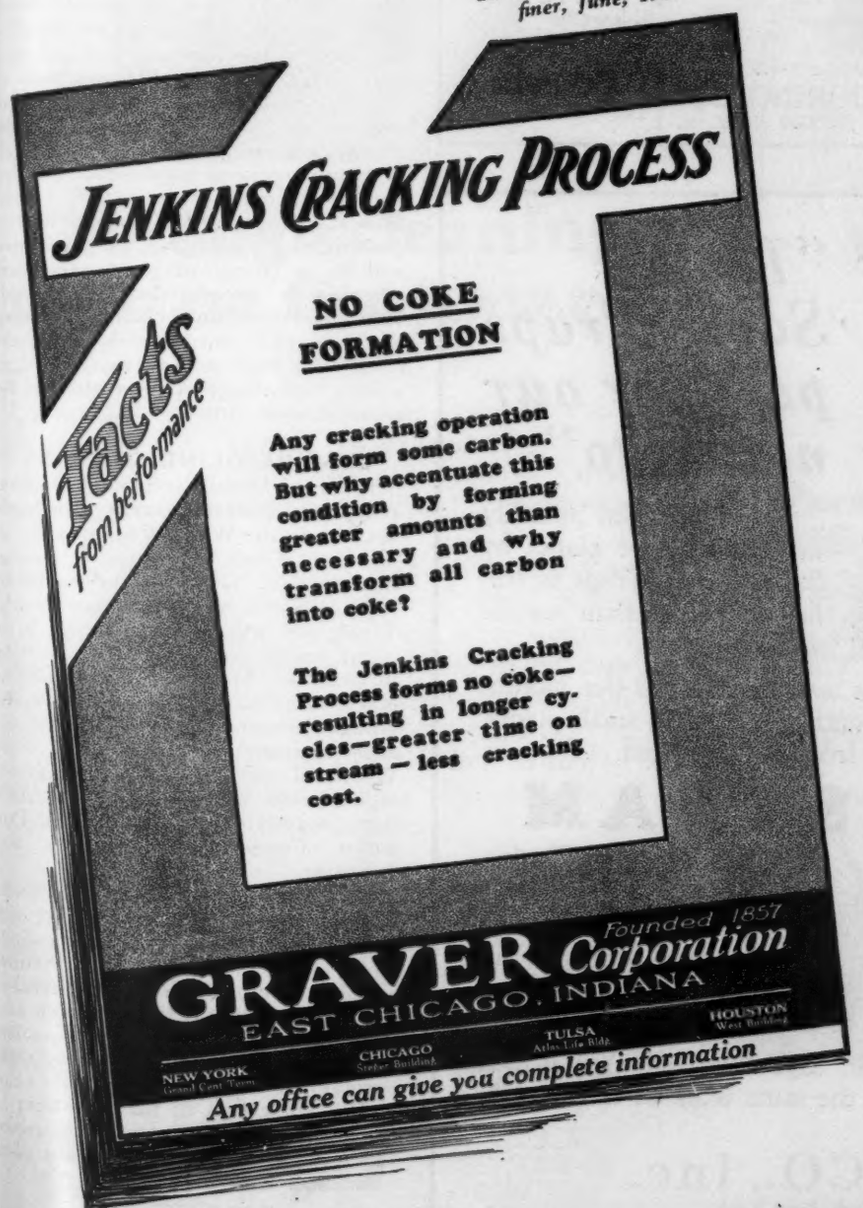
655 Roosevelt Building,
Los Angeles, Calif.
Phone TRinity 4661

ERECO DUPLEX

1313 Athletic Building,
Dallas, Texas
Phone 26310

Mention Where You Saw the Advertisement

This is a reproduction of an advertisement in Refiner, June, 1925


JENKINS CRACKING PROCESS
Facts from performance
NO COKE FORMATION
Any cracking operation will form some carbon. But why accentuate this condition by forming greater amounts than necessary and why transform all carbon into coke?
The Jenkins Cracking Process forms no coke—resulting in longer cycles—greater time on stream—less cracking cost.
Founded 1857
GRAVER Corporation
EAST CHICAGO, INDIANA
NEW YORK Grand Cent. Term.
CHICAGO Strebe Building
TULSA Atlas Life Bldg.
HOUSTON West Building
Any office can give you complete information

The refiner today is considering only that cracking process which delivers its product to the tanks rather than the coke pile.

Production of liquid products only has always been inherent with the Jenkins Process.

~ REFINERY DIVISION ~

GRAVER Founded 1857 Corporation

844 Rush Street ~ Chicago

NEW YORK FORT WORTH LOS ANGELES

Plant — East Chicago, Indiana

Mention Where You Saw the Advertisement

SPECIFY Kerlow Gratings and Safety Steps For :

KERLOW
GRATING PRODUCTS
JERSEY CITY, N. J.

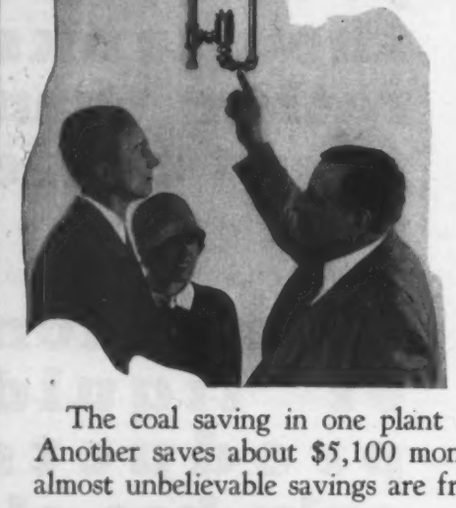
WALKWAYS
Boiler Room Floors
Turbine Room Floors

AREAWAYS
Fire Escapes
Platforms

SUBWAYS
Sidewalks
Trench Covers

Write for Catalogue F66E

KERLOW STEEL FLOORING COMPANY
220-224 CULVER AVE., JERSEY CITY, N. J.



"Those Sarco Traps paid for our new auto"

The fuel saved monthly in thousands of plants by Sarco Steam Traps is sufficient to more than pay for an automobile.

The coal saving in one plant averages $7,500 per month. Another saves about $5,100 monthly. Even in small plants, almost unbelievable savings are frequently effected.

SARCO STEAM TRAPS

cost only one-third the price of most traps, and there is practically no installation cost, for they're self-adjusting for all pressures from 0 to 100 lbs. and they screw right into the pipe line, doing away with supports or pit.

Let us send you a Sarco on 30 days' free trial. You'll then see for yourself that it will do the same work as large costly traps.

SARCO CO., Inc.
183 Madison Ave., New York

BOSTON BUFFALO CHICAGO CLEVELAND DETROIT PHILADELPHIA PITTSBURGH ST. LOUIS
Peacock Bros., Lt., Montreal

Free Trial Coupon

Sarco Co., Inc.,
183 Madison Ave., New York, N. Y.
Please send the following on 30 days' free trial:
( ) No. 9 Sarco Steam Trap, size (½", ¾", 1")
( ) Booklet S-230.

Name .....
Address .....
City .....

REFINERY AT DEL RIO

The Del Rio Refining Company, a subsidiary of the Amarillo Producers & Refiners Corporation, which is operating refineries at Borgar and Pyote, Texas, started construction work early in December on a 2500-barrel daily capacity skimming plant on a 38-acre site on the Southern Pacific Railroad at Del Rio, Texas. This plant will operate on Yates field crude that will be supplied on contract by the Mid-Kansas Oil & Gas Company, and delivered direct from the field to the plant via the Illinois Pipe Line Company's trunk line.

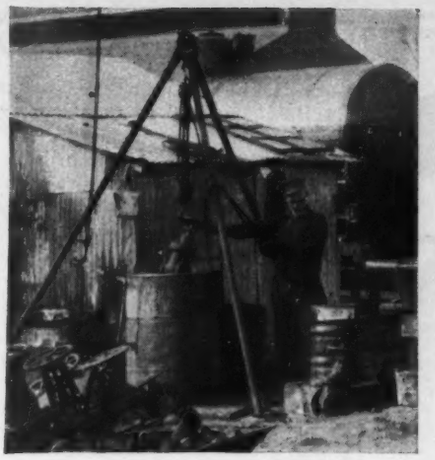
J. D. Wrather, Amarillo, president of the Amarillo Producers & Refiners Corporation, will be president of the above new refining concern, while R. P. Humes, general manager of the San Angelo Refining Company, and Tracey Cowell, Jr., both of San Angelo, will be officials of the company. A. V. Raplee will be in charge of plant operations when it is completed about April 1, 1929. The Del Rio Refining Company has obtained a contract with the Southern Pacific Railroad for the disposal of a large percentage of the fuel oil to be manufactured.

NEW GASOLINE COMPANY

Trinity Natural Gasoline Company, a newly organized concern with headquarters in the W. T. Waggoner Building, Fort Worth, is erecting an absorption gasoline plant on the northeast edge of Santa Anna, Coleman County, Texas, and will begin operating same about middle December. H. T. Owen, formerly in charge of natural gasoline plants in Texas for the Marland Refining Company, is president of the new company; H. H. Adams, Fort Worth oil operator and consulting geologist, is vice president; and L. R. Williams, formerly with the Marland Production Company, is secretary and treasurer.

The Santa Anna plant will handle about 1,500,000 cubic feet of gas, with an expected yield of about 3500 gallons daily. Officials of the Trinity Natural Gasoline Company recently purchased at receivers' sale the three Newton process plants of the American Gasoline Corporation in the Wascom and Breckenridge fields. The Wascom field plant is idle, while part of the equipment at the Breckenridge plant is being moved to Coleman County for use in the plant now under construction.

During the early part of November H. M. Stalcup, T. R. Goebel, J. R. McWilliams and Emby Kaye, all of the Skelly Oil Company, Tulsa, headquarters office spent several days touring through the Panhandle area where they visited the Schafer, Borger and Armstrong plants and properties. At Armstrong a temporary site for a new gasoline plant was selected. Preliminary to the erection of a permanent natural gasoline plant on the Armstrong lease, a type 75 Southwestern absorption unit is being installed to process the natural gas from the first few wells completed on this lease.



Thorough cleaning with no fire hazard

LARGE savings of time and hard work are important advantages offered by Oakite cleaning. Even with the simplest of equipment—as one southern oil company recently found — Oakite methods are unmatched in speed and thoroughness.

Here an oil drum was filled with a solution of an Oakite material and heated by gas. Gate valves, pipe fittings and similar equipment were soaked a short time and removed, rinsed, and found *completely clean*. No hand scrubbing was necessary.

You clean safely, too, the Oakite way. Water solutions eliminate all fire hazard. Decide now to find out more about Oakite cleaning.

Our booklet "Oakite in the Oil Industry" gives directions and suggestions for a wide range of cleaning operations. Let us put a copy in the mail for you.

Manufactured only by

OAKITE PRODUCTS, INC., 50B Thames St., NEW YORK, N. Y

Oakite Service Men, cleaning specialists, are located at

Albany, N. Y., Allentown, Pa., *Atlanta, Altoona, Pa., Baltimore, Birmingham, Ala., *Boston, Bridgeport, *Brooklyn, N. Y., Buffalo, *Camden, N. J., Canton, O., Charlotte, N. C., Chattanooga, Tenn., *Chicago, *Cincinnati, *Cleveland, *Columbus, O., *Dallas, *Davenport, *Dayton, O., Decatur, Ill., *Denver, *Des Moines, *Detroit, Erie, Pa., Fall River, Mass., Flint, Mich., Fresno, Cal., *Grand Rapids, Mich., Harrisburg, Pa., Hartford, *Houston, Texas, *Indianapolis, *Jacksonville, Fla., *Kansas City, Mo., *Los Angeles, Louisville, Ky., Madison, Wis., *Memphis, Tenn., *Milwaukee, *Minneapolis, *Moline, Ill., *Montreal, Newark, N. J., Newburgh, N. Y., New Haven, *New York, *Omaha, Neb., Oshkosh, Wis., *Oakland, Cal., *Philadelphia, Phoenix, Ariz., *Pittsburgh, Pleasantville, N. Y., Portland, Me., *Portland, Ore., Poughkeepsie, N. Y., Providence, Reading, Pa., Richmond, Va., *Rochester, N. Y., Rockford, Ill., *Rock Island, Sacramento, *San Francisco, *Seattle, Springfield, Mass., South Bend, Ind., *St. Louis, *St. Paul, Syracuse, N. Y., *Toledo, *Toronto, Trenton, *Tulsa, Okla., Utica, N. Y., *Vancouver, B. C., Waterbury, Conn., Wichita, Kan., Williamsport, Pa., Worcester, Mass.

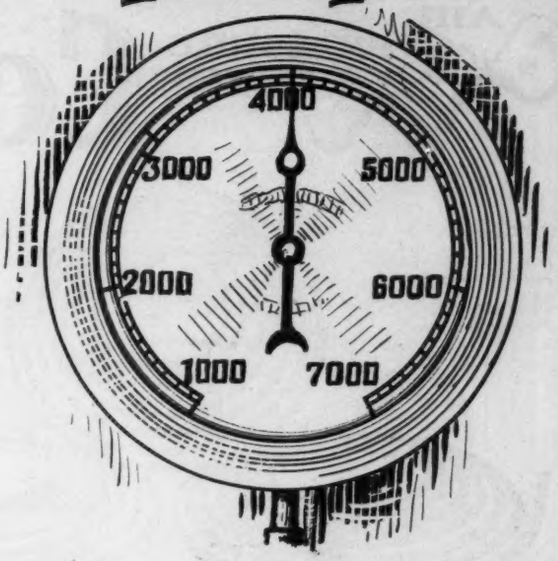
*Stocks of Oakite materials are carried in these cities.

OAKITE

TRADE MARK REG U S PAT OFF

Industrial Cleaning Materials and Methods

Proportioning pumps

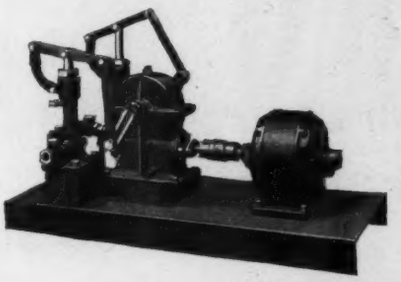


For Pressures Up to 4,000 lbs. Capacities from 0 to 300 G.P.H.

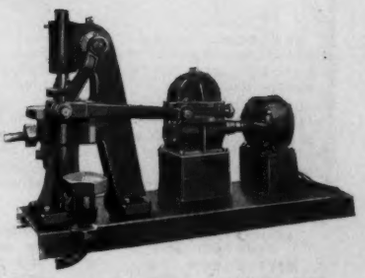
Hills-McCanna Proportioning Pumps are mechanically and automatically reliable. They eliminate the human element in treating processes and practically banish the dangers of under or over dosing.

Types are available to suit local power take-off conditions in capacities of less than one gallon per hour up to three hundred gallons per hour—for pressures from an ounce to 4,000 lbs.

Write for bulletin R-12, describing the complete line.



"L" Type — Double acting pump — Motor Driven through reduction gears.



"G" Type—For feeding liquids with solids in suspension and pressures.

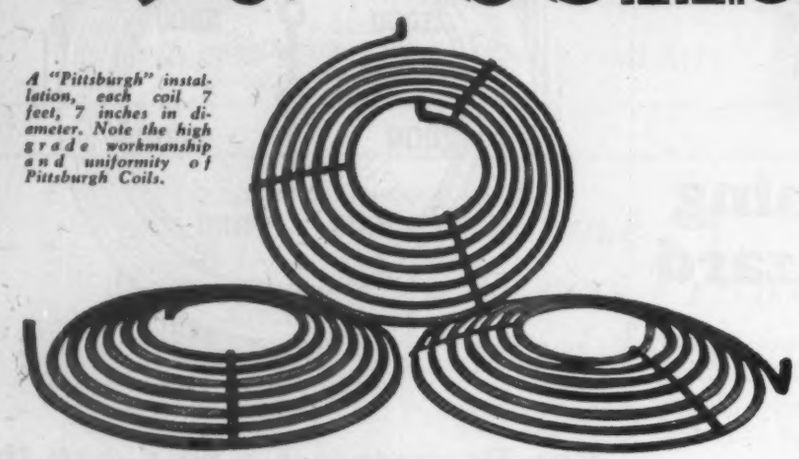
HILLS-McCANNA CO.

2349-59 Nelson St., *Chicago*

THE MOST COMPLETE SERIES OF ALLOYS FOR INDUSTRIAL USE. FORCE FEED LUBRICATORS, PROPORTIONING PUMPS, SPEED REDUCERS

Pittsburgh AIR PRESSURE TESTED Coils

A "Pittsburgh" installation, each coil 7 feet, 7 inches in diameter. Note the high grade workmanship and uniformity of Pittsburgh Coils.

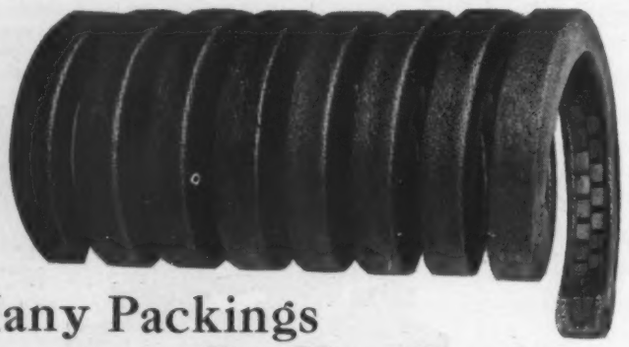


Let us quote on your requirements; Pittsburgh-built Coils built to your specifications.

Pittsburgh Pipe Coil & Bending Co.

P. O. Box 975, PITTSBURGH, PA.

Because of "V" Pilot's patented construction which provides a tight seal that holds the pressure, fewer rings of "V" Pilot are needed, thus reducing packing cost.



How Many Packings Do You Stock?

CARRYING a stock of a variety of packings for miscellaneous applications is a thing of the past in many refineries and natural gasoline plants.

For "V" Pilot Packing can be practically standardized in every packing application throughout the refinery and natural gasoline plant.

On oil, gasoline, earth, sludge, acid and slush pumps, air compressors (both steam and air ends), gas compressors in the extraction plant, ammonia compressors, hydraulic presses in the wax plant, stop valves and valve stems—to mention only a few applications—"V" Pilot Packing has demonstrated its suitability through long, satisfactory service.

Distributors (listed at the left) stock "V" Pilot packing in spiral form in ten-foot lengths. It is also furnished in ring form when so ordered. A trial of "V" Pilot will indicate its adaptability for your service. Get in touch with the nearest distributor today, or if you wish, write us direct.

Distributors

BEAUMONT, TEXAS
Norvell-Wilder Hardware Co.
BUFFALO, NEW YORK
Buffalo Mill Supply Co.
CHICAGO, ILLINOIS
O. C. Keckley Company
DENVER, COLORADO
Mine & Smelter Supply Co.
FORT WORTH, TEXAS
Norvell-Wilder Hardware Co.
HOUSTON, TEXAS
Texas Rubber Specialty Co.
LOUISVILLE, KY.
Graft-Pelle Co.
PITTSBURGH, PA.
Argo Asbestos & Rubber Co.
ST. LOUIS, MISSOURI
J. P. Bushnell Packing & Supply Company
SHREVEPORT, LA.
Norvell-Wilder Hardware Co.
TOLEDO, OHIO
Hardy & Dischinger
TULSA, OKLAHOMA
Mid-Continent Sales Service Company

THE NEW JERSEY ASBESTOS COMPANY
One Water Street, New York, N. Y.

Philadelphia, 216 Walnut St.
Baltimore, 17 So. Gay St.
San Francisco, 37 Spear St.
Boston, 148 Pearl St.
Norfolk, 111 E. Main St.
Wilmington, Cal., 236 Avalon Blvd.

"V" PILOT PACKING

NEW GASOLINE PLANTS IN SEMINOLE AREA

In the Mission pool, just west of the Bowlegs pool of the Greater Seminole area, Oklahoma, Gypsy Oil Company is to begin construction immediately of a new absorption natural gasoline plant in SW NE Section 7-8-6 which will have an initial capacity of 30,000 gallons daily, with provision for enlargement.

In the same new field the Independent Oil & Gas Company has under construction an eight unit combination gas lift and gasoline plant on its Payne lease in Section 7-8-6. This plant has a rated capacity of 10,000 gallons per day.

In the Maud pool, located four miles west of the Mission pool, Amerada Petroleum Corporation intends to start construction immediately of an absorption type natural gasoline plant in Section 7-8-5. This plant will treat gas from neighboring producing properties and is expected to have 50,000 gallons capacity early in 1929.

Shell Petroleum Corporation contemplates the construction of a plant, possibly in Section 7-8-5, North Maud istrict. In Section 29-7-5, east of the St. Louis field, Shell Petroleum Corporation has under construction a 50,000 gallon gasoline plant, the first units of which were recently placed in operation. Residue gas from this plant will be used in gas lift work.

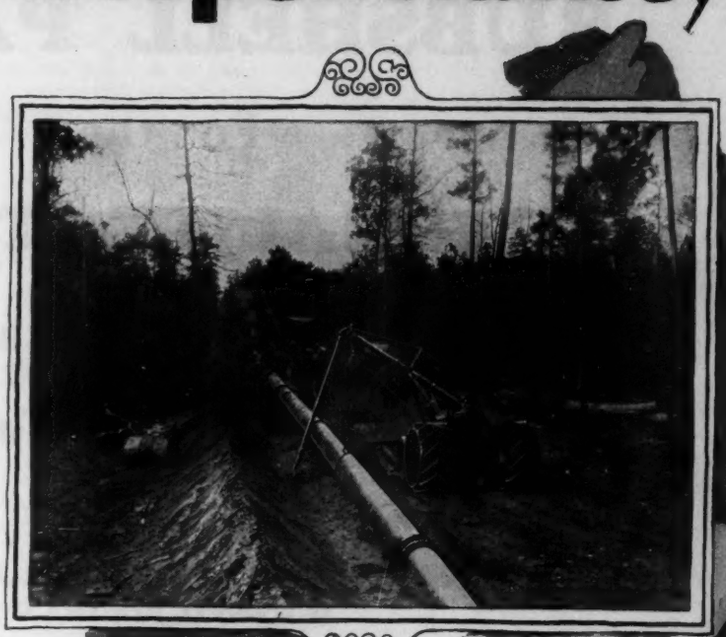
EASTLAND COUNTY

Chestnut & Smith Corporation started construction work early in November on a natural gasoline plant to be located on the B. L. Hargus farm, located in the southeast quarter of Section 13, H. & T. C. Ry. survey, Block 2, Eastland County, to operate on gas being produced in the Sibley pool. The absorption process is to be used in this plant, which will handle about three million cubic feet of gas daily. The field is making more than 15,000,000 cubic feet of gas daily, but a large portion of this is dry. The residue gas and a large volume of dry gas is to be sold by Chestnut & Smith Corporation for fuel to the electric generating plant of the Texas Electric Service Company.

ADD BURNING HOUSES

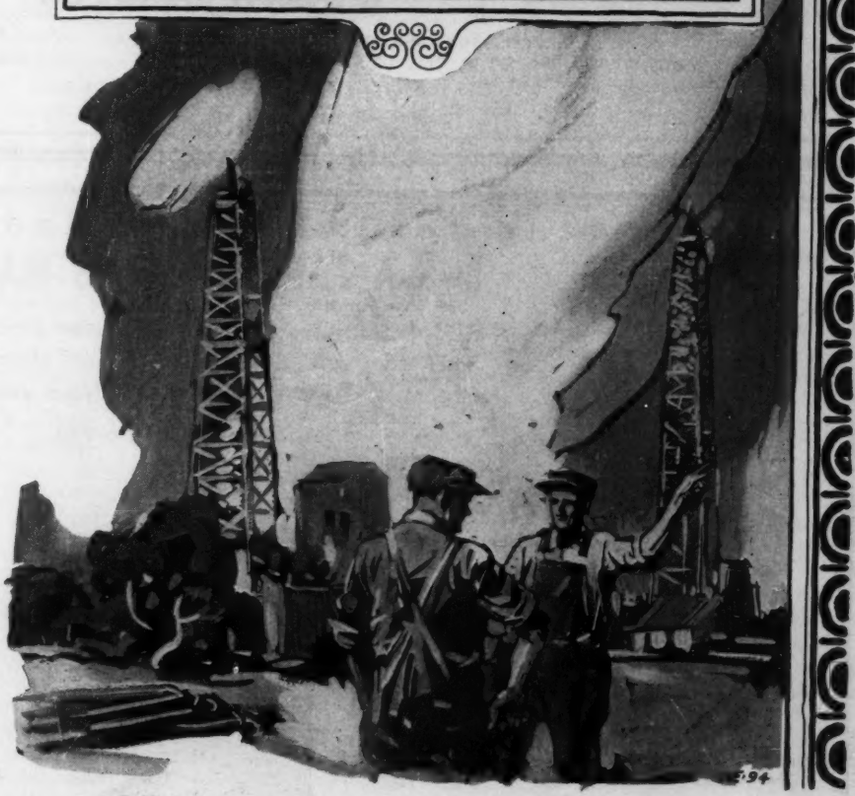
Magnolia Petroleum Company purchased materials late in November to add 10 new burning houses to its carbon black plant No. 3, located in Section 91, Block 4, I. & G. N. Ry. Survey, Carson County, near Skellytown. This plant was completed in October, 1928, with 30 burning houses, and is burning between six and seven million cubic feet of residue gas daily, with a recovery of about one pound of black per 650 cubic feet of gas. The new equipment will bring the number of burning houses to 40, with a total burning capacity of about 10,000,000 cubic feet daily.

Unified Responsibility



The Hope Company is the one organization serving the natural gas and oil industry which is ready and qualified to assume entire responsibility for a pipe line enterprise "from well to meter." It is not only ready, but it has repeatedly done so—to the satisfaction of all concerned.

More than this, the Company is ready also to undertake field surveys, market analysis, and aid in financing and organization—as it has repeatedly done in the past.



HOPE

ENGINEERS CONTRACTORS

HOPE ENGINEERING COMPANY

DESIGNERS MANUFACTURERS

MOUNT VERNON, OHIO, U.S.A.

NEW YORK, N.Y. DALLAS, TEX. TULSA, OKLA. CASPER, WYO. HOUSTON, TEX. SHREVEPORT, LA. LOS ANGELES, CAL.

Mention Where You Saw the Advertisement

RUBSHELL PAINTS

For the

INTERNAL PROTECTION

of Storage Tanks, Refining Plant,

Tank Wagons and Tankships

Sole Manufacturers

INTERNATIONAL COMPOSITIONS COMPANY

25 Broadway, New York City

Agent for Louisiana
WOODWARD, WIGHT & CO., LTD., NEW ORLEANS

Agent for California
C. G. CLINCH & CO., SAN FRANCISCO AND SAN PEDRO

"Everything for Mine and Industrial Safety"

M-S-A TANK GAUGERS MASKS

Afford Complete Protection Against Hydrogen-Sulphide Gas and Other Fumes from Sour Crudes and Distillates. Two Types Available.

Write for Bulletin No. 100

Type "C" Mask

A Canister Type Mask with single inhalation tube.

Developed especially for Tank Gaugers, Pipe Line Inspectors and Repairmen, Pumphouse Men and others who may be exposed, in unconfined places, to deadly Hydrogen Sulphide Gas from Sour Crudes and Raw Distillates. Supersize Canisters are used in all M-S-A Tank Gaugers' Masks.

Type "C" Mask in Use

M-S-A Hose Masks (Fresh Air Type) should be used in all confined spaces where Deficiency of Oxygen or High Concentrations of Petroleum Vapors may exist. Write for literature.

Manufactured only by the

Mine Safety Appliances Co.

Braddock Ave. & Thomas Blvd., Pittsburgh, Pa.

Type "D" Mask

A Canister Type Mask with double inhalation tube.

The Face Piece fastens to the two Flexible Inhalation Tubes, one over each shoulder, joining a substantial Y connection in the back between the shoulders. This arrangement assures the wearer an uninterrupted supply of air, even though one tube be temporarily closed.

ABSTRACTS OF TECHNICAL LITERATURE

Of Particular Interest to the Plant Operator

From: The Petroleum Industry in 1927. *Kissling. (Erdol u. Teer, Sept.* 5, 1928, *p.* 44. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 40.) *Continued from December issue of* THE REFINER. Meiro and Meurice conduct the cracking distillation at relatively low temperature by using a heating bath charged with petroleum residuum. The batch method by which end-point gasoline is produced immediately and the Richey apparatus serving this purpose are described by Singer, Neubronner and Wilson. Berthelot discusses the Dubbs process, Holmes, the Holmes-Manley, Kroch, a cracking plant with tube still.

Numerous processes deal with physical or dry refining. Bentonite "activated" with acid is proposed by Kauffman, silica gel impregnated with sulfuric acid (Sulfosil) by Tytschinin and Tokenanow, the preliminary removal of the petroleum acids by Nobel, etc. The newer refining processes are described by McTee, Francis and Miller, desulfurizing processes by Challenger, processes for dry-refining by Tarassow, Gross, Gasiorowski and Wadsworth.

Peltier gives data upon the construction of filter plates for use in removing the oil from paraffin pulp. Smith has studied the suitability of the solvents acetone, isopropyl alcohol, secondary butyl alcohol, etc., for making paraffin; Twerzyn experimented in working up "paraffin tar" from Grosny petroleum. According to Buchler and Graves the varieties of paraffin may be distinguished as paraffin, the slop wax obtained from viscous oil and converted by redistilling into paraffin, the petrolatum wax obtained from petroleum residuum, and soft wax (soft paraffin). Mayer describes the manufacture of natural, artificial and paravaseline.

Distillation

Molecular Stills. Washburn. (Paper presented at the Swampscott meeting of the A. C. S., September. 10-14, 1928). A type of still is described with which it is possible to carry out distillation of organic compounds at temperatures where vapor pressure of the substance to be distilled is extremely small, for example, not greater than one millionth of a millimeter of mercury. Many organic substances which ordinarily are not distilled because they cannot be heated without decomposition can be rather easily distilled even at room temperature in this type of still. The essential features of the still are the following:

1. A high vacuum. For securing this vacuum, a pump should be available which will produce vacuum equal to or preferably better than the vapor pressure of the substance at the highest temperature at which it can safely be distilled.

2. A large and clean area of evaporating surface.

3. A short distance between the evaporating surface and the condenser.

4. A large temperature difference between the distilling surface and the condensing surface.

Cracking

Gases from Cracking. Dunstan. (From Cantor Lectures before the Royal Society of Arts on the Scientific Foundations of the Refining of Petroleum. Libr. Bull., U. O. P. Co., Vol. 3, *No.* 40.) Liquid-phase cracking at temperatures of 450 to 480 degrees C. (842 to 896 degrees F.) produces a gas containing only from 8 to 13 per cent. of unsaturated hydrocarbons. Vapor-phase cracking at a temperature of 600 degrees C. (1112 degrees F.) and over produces a gas having 30 to 75 per cent. of unsaturated hydrocarbons. The same gases are usually found in both types, but in different proportions. Liquid-phase cracking produces relatively little ethylene and only a trance of diolefins, the vapor-phase gas may contain 25 per cent. of ethylene and sometimes over 2 per cent. of diolefins.

Ethylene is the starting material for mustard gas both by Pope's methods and by the original German method.

Ethylene is a better anaesthetic than chloroform or ether, being without depressing action on the heart. Propylene is better than ethylene, but polymerizes on standing.

The following figures represent an analysis of the unsaturated content (55.75 per cent. of the total gas) in a vapor-phase cracking operation:

Ethylene	54 %
Propylene	28 %
Butylene	9 %
Amylene	1.7%
Higher Olefins	6.1%
Butadiene	1.2%

Treating

Refining of Cracked Oil. Tomekichi Kan. (Jour. Soc. Chem. Ind. (Japan) 30 129 (1927). *C. A. Apr.* 20, 1927, *p.* 1344.) The cracked oil used in the experiment had a density at 14 degrees of 0.834 and iodine value of 48.02, and contained 1.15 per cent. sulphur. The oil was distilled and density, iodine number, and percentage of sulphur determined for every fraction. When the cracked oil was shaken with an alcoholic solution of mercuric chloride, there separated $C_2H_6SHgCl_2$ and $C_4H_{10}SHgCl_2$. Similar compounds of higher homologs and some polymerization products seemed to separate out. The remaining oil no longer had a disagreeable odor, and it contained less sulphur. The cracked oil can also be refined by heating it with anhydrous copper sulfate. The oil loses its disagreeable odor, sulphur dioxide escapes, and most of the copper sulfate is reduced to copper sulfide. Kan. ascribes this deodorizing to the action of CuO and the nascent oygen on the organic sulfur compound, CuO and O being formed by the decomposition of $CusO_4$. Refining by washing with liquid sulphur dioxide was studied. The refined oil has no disagreeable odor and is stable to light and air. Ethyl sulfide was very soluble in the sulfur dioxide.

The Origin of Hydrogen Sulfide in Mexican Crude Oil and Its Removal in Refining These Oils. Donath. (Erdol u. Teer, 3, 155. *Chem. Zentr., Oct.* 19, 1927, *p.* 2027, *Libr. Bull., U. O. P. Co., Vol.* 2, *No.* 46, *p.* 414.) The presence of hydrogen sulfide in crude oils is referred to the decomposition of proteins of the organisms whose fats predominated as material for forming the oil. Pyrolusite (MnO_2) is recommended for absorbing the hydrogen sulfide from the air.

Filtration

Bauxite. Dunstan. (From: Cantor Lectures on Scientific Foundations of the Refining of Petroleum, delivered before the Royal Society of Arts, Jan., 1928. *Libr. Bull., U. O. P. Co., Vol.* 3, *Nos.* 39 *and* 40.) Bauxite is made up of hydrated aluminum and ferric oxides with lime, titania, magnesia, and silica present in varying amounts. It becomes porous in structure when heated to a temperature high enough to drive out the water of combination, and then if used hot (200 degrees) will remove both coloring matters and sulfur compounds from kerosene and lighter oils. The adsorbed organic matter can be extracted from the spent bauxite with benzine, and if the bauxite is then heated to high temperature it is ready to use again. Superheated steam or to a lesser extent hot water will remove the adsorbed sulphur compounds. Freundlich's law $(x/m)^n$ is proportional to c, in which x is the per cent. of original color removed, m is the weight of bauxite per hundred parts of kerosene, c is the original concentration of color, and n is a constant, was by experiment shown to hold approximately in the adsorption of color compounds by bauxite. The deviation from the law was greater in the adsorption of sulphur compounds, probably because of the presence of colored compounds, which are adsorbed preferentially.

The polymerizing action of bauxite is seen in the fact that if cracked gasoline is filtered through it cold, the color is much darker than the original. The same is true if the gasoline is filtered at 100 degrees. But if it is filtered at 200 degrees, at which temperature it is mostly vaporized, it comes through clear and colorless. The polymers formed in the pores are washed out by the liquid gasoline; with the gasoline in the vapor phase they remain behind. The sulphur compounds behave similarly. Bauxite may be used for refining, then, in either of two ways: (1) the gasoline may be run through at

To Prevent a Vacuum

The *Fulton Duplex Sensitive Vacuum (or Back Pressure) Regulator* is designed for use on a system discharging gases to a line under light vacuum, where it is desired to maintain atmospheric pressure.

This regulator acts as a safeguard when used on the vapor lines connected to storage tanks and prevents the pulling of a vacuum when adjusted as a vacuum regulator.

The same regulator may be adjusted to act as a *Duplex Back Pressure Regulator* and will control a slight pressure above atmosphere with the same accuracy as when used to control a light vacuum.

Send for catalog.

CHAPLIN-FULTON MFG. COMPANY
28-40 Penn Ave., Pittsburgh, Pa.

PULMOSAN
CHEMICAL CARTRIDGE
RESPIRATOR

Absolute Protection

The use of the Pulmosan Chemical Cartridge Respirator will eliminate the danger arising from poisonous fumes and vapors when paint spraying.

This respirator received the highest rating from the National Safety Council Committee on Spray Coating.

Write for Descriptive Literature

Pulmosan Safety Equipment Corp.

182 Johnson St., Brooklyn, N. Y.

200 degrees, completing the removal of the objectionable compounds in one operation but leaving the bauxite contaminated; (2) filtering at 100 degrees and redistilling the filtrate.

Sulphur compounds are polymerized by filtering at 100 to 130 degrees after which they are more easily removed in filtering at the ordinary temperature. A kerosene containing 0.31 per cent. of sulphur was filtered at 120 degrees in the proportion of one pound of bauxite per gallon. It still contained 0.26 per cent. of sulphur. It was then filtered through the same proportion of cold bauxite, which lowered the sulphur content to 0.16 per cent. Filtration in the cold, two pounds of bauxite to a gallon of kerosene, left 0.26 per cent. of sulphur in the oil.

The four steps now taken in the use of bauxite are: filtering a predetermined quantity of oil through a definite amount of bauxite; steaming out the filter till no more kerosene can be removed economically; grinding up fresh bauxite to size and adding enough to make up the loss; roasting to drive out the moisture and the last traces of kerosene and to burn out the organic matter and carbon.

The colored compounds in oil are present in colloidal suspension. The sulphur compounds are in true solution. Filtering through bauxite will remove most of the colored compounds before taking out any of the sulphur, because the colloidal material covers the pores preventing adsorption of substances in true solution. If instead of a single deep filter the bauxite is divided up in a series of filters so that the process can be followed closely, it is seen that while the color grows progressively lighter, no sulphur is removed till the oil is largely freed of colored compounds. In a case for which figures are given no sulphur was removed till 12 per cent. was taken out in the fourth filter; and 52 per cent. was removed in the fifth.

Superheated steam at 150 degrees is used for steaming out and the process is continued till the moisture and kerosene remaining amounts to 7.12 per cent. A temperature of 550 degrees, with ample air supply and sufficient time allowed, is the optimum for roasting. In the operation of steaming, the adsorbed sulphur compounds are not dislodged from the pores till most of the kerosene has been distilled out; so that most of the kerosene is ready for refiltering as recovered. An occasional sieving of the used bauxite removes the dust from and keep it up to the original activity. Horizontal rotary furnaces have advantages over the multiple-hearth vertical furnaces for roasting. Flue gases containing sulphur dioxide reduce the activity of the bauxite in the removal of sulphur from the oil. Investigation has shown that certain sulphur compounds are capable of being adsorbed in the bauxite, but the mercaptans pass through without being adsorbed. This is the explanation of the fact that bauxite roasted in a laboratory furnace, with its external heating, gives better adsorption than furnaces with internal heating; and is the reason for using fuels as free from sulphur as possible.

Sulphur, color, and odor removal are all favored by low temperature. Nearly

Hytempite comes sealed in steel

Always ready for use

Thinning to a Pancake Batter

Hytempite Batter stays in Perfect Suspension

Reduce Costly Repairs and Shut-Downs with

HYTEMPITE

(Reg. U.S Pat. Off.)

The Universal High Temperature Cement

HYTEMPITE is universally used because it

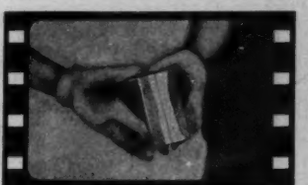
—is easy to use
—makes a thin joint
—permits hot patching
—comes sealed in steel
—insures reduction of heat losses
—reduces amount of fuel consumed
—makes a tough bond throughout the wall
—resists destruction from constant vibration
—expedites repairs—prevents long shut-downs
—eliminates the possibility of shrinkage cracks
—allows furnace operation at high temperatures
—makes a perfect seal—prevents infiltration of air
—air sets and does not depend on heat for strength
—retains strength at temperatures at which fire brick fail
—can be shot in place with a Quigley Refractory Gun
—is ideal refractory, when used with crushed old fire brick

Let us help solve your furnace problems. Write to us.

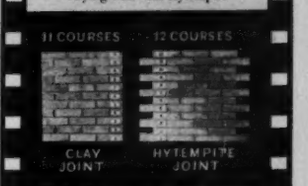
QUIGLEY
Furnace Specialties Co., Inc.

26 Cortlandt Street New York

Stock and service in over 100 important industial centers throughout the world


Shows thin joint obtained

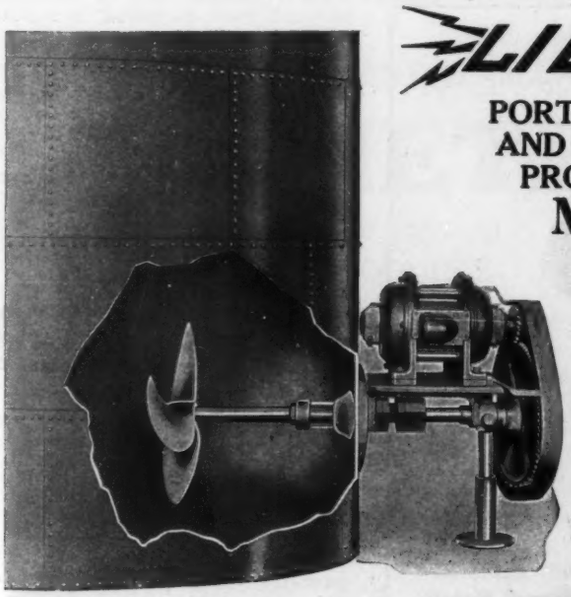
Laying wall with Hytempite



Thick Clay Joints vs. Thin Hytempite Joints

Hytempite Joints have great strength

HYTEMPITE is a Product of the Quigley Furnace Specialties Co., Inc.

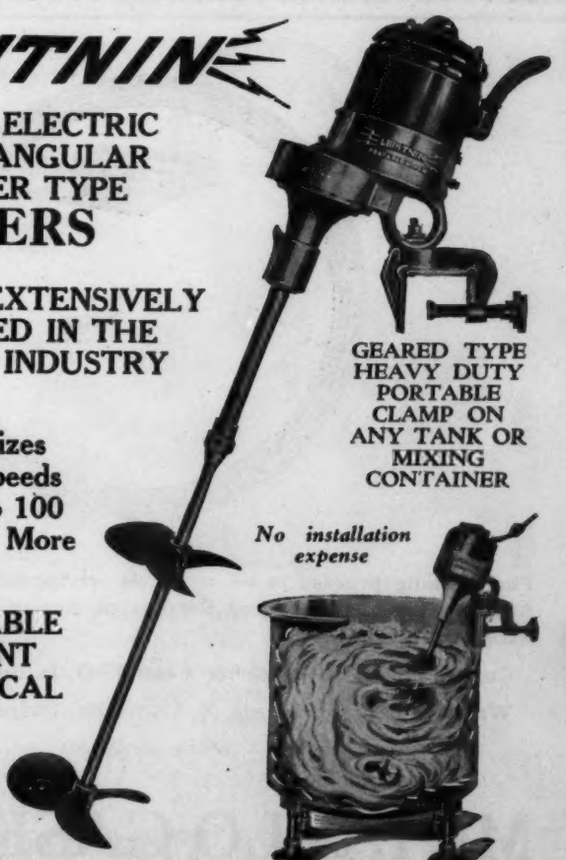


LIGHTNIN

PORTABLE ELECTRIC AND SIDE ANGULAR PROPELLER TYPE MIXERS

ARE EXTENSIVELY USED IN THE OIL INDUSTRY

All Sizes and Speeds 1-20 to 100 H.P. or More



GEARED TYPE HEAVY DUTY PORTABLE CLAMP ON ANY TANK OR MIXING CONTAINER

No installation expense

DEPENDABLE EFFICIENT ECONOMICAL

SIDE ANGULAR PROPELLER TYPE AGITATOR FOR TANKS OF ANY SIZE OR SHAPE

Mixing Equipment Co., Inc.

229 EAST 38 ST. NEW YORK, N. Y.

Patent Pending

SPECIALIZING IN REFINERY PIPING

Known Throughout the Field

Power Piping

Ask Our Engineers' Advice

Fabricating and erecting, in collaboration with your own engineers if necessary,—designs by our own organization or as specified by you,—anything in refinery or process piping.

POWER PIPING CO.
PITTSBURGH, PA.

For cracking process in oil refineries we furnish Aluminum Armored Asbestos filled Gaskets and Corrugated Armco Iron or Monel Metal Asbestos encased.

Copper rings 3/16" thick for 4 and 5" O. D. tubing.

Washers or gaskets made of Aluminum, Copper and other Metals.

Write for Prices.

METALLO GASKET CO.
NEW BRUNSWICK, N. J.

twice the quantity of sulphur compounds was removed in some laboratory trials at —10 degrees C. (14 degrees F.) that could be taken out at 150 degrees C. (302 degrees F). To take advantage of this and at the same time to avoid letting the bauxite stand and absorb moisture after roasting, it is blown at very high speed in closed pipes from the furnaces to the filter and is nearly cold by the time it reaches the filter. The same dried air is used over and over again.

OF PARTICULAR INTEREST TO THE REFINERY AND CHEMICAL ENGINEER

Chromium in the Oil and Automobile Industries. Humphreys. (*Automotive Industries, Apr.* 30, 1927. *Petr. Times, Sept.* 3, 1927, *p.* 446. *Libr. Bull., U. O. P. Co., Vol.* 2, *No.* 38, *p.* 330.) Advantages in the use of chromium in refining equipment and automobiles.

(1) It is unattacked by any acid except hydrochloric.

(2) In marked contrast with iron it has very little affinity for sulphur.

(3) Soft metals, like zinc, lead, brass, tin and babbitt metal, do not adhere to it readily; so that with crank shafts plated with chromium there should be little tendency of the bearings to freeze.

(4) A very thin plating suffices to protect against scratches (0.0003 in.) or tarnish in radiator shells (0.0006 in.)

(5) Carbon will not adhere to chromium, an important consideration in cracking; the deposit is loose and can be blown away.

(6) The pistons of hot oil pumps can be protected from corrosion by a plating of chromium.

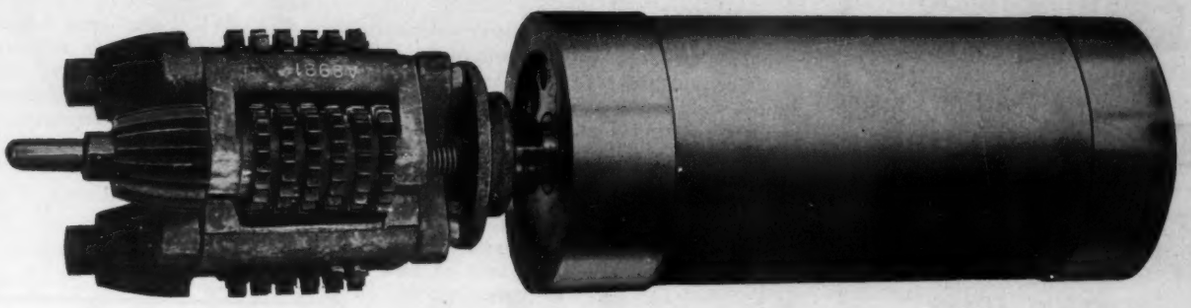
(7) Chromium is a better reflector than silver after the latter has been polished repeatedly.

Chromium can be plated in thinner layers than nickel, but a positive contact is required, which means more labor.

Coated Spiral Fractionating Columns. Midgley, Jr. (*Paper presented at the Swampscott meeting of the A. C. S., Sept.* 10-14, 1928.) A new fractionating column has been devised, specially suitable for the separation of hydrocarbon mixtures. It is substantially a metal spiral column, rendered adiabatic by insulation and compensation heating coils. The novel feature is the coating of the spiral with carborundum. The coating procedure is as follows: Fill the column with a thin shellac solution in alcohol; drain, blow air saturated with alcohol vapor to remove the excess of shellac; blow 60-mesh carborundum, until the particles come through; blow dry air; remove the last traces of alcohol by distilling benzene. When a multiple spiral column is constructed, only one spiral should be coated at a time. Shellac is suitable as a binder only for hydrocarbons. The efficiency of this column surpasses that of any other model. m-Xylene boiling within 0.5 degrees was obtained from crude commercial xylene by two re-runs.

The effect of Additions of Lime and

ROTO TUBE CLEANERS



Roto Air-Driven Heavy Duty Cleaner
For

CRACKING STILLS

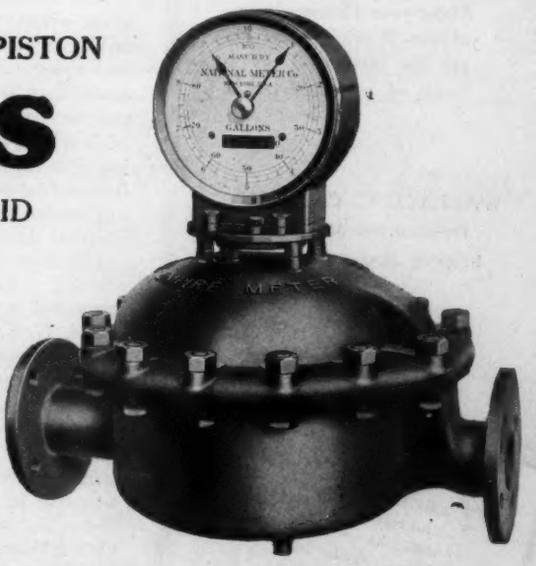
THE ROTO CO. **Sussex Avenue and Newark St.,** **NEWARK, N. J.**

POSITIVE DISPLACEMENT OSCILLATING PISTON

OIL METERS

FOR PETROLEUM AND ALL ITS LIQUID PRODUCTS

Entirely different from any other type of oil meter



The EMPIRE

In successful use for over forty years. Never equaled for *lasting* accuracy. Easy to install and operate. Very low in maintenance cost. Invaluable for Refinery work. All sizes from 5/8" to 6" inclusive. Made to withstand working pressures of 300 pounds to the square inch. Standard types for general use will sustain 150 pounds. Special types for still higher pressures and for special requirements.

Send for fully descriptive circular and EMPIRE information sheet, and let us make recommendations for your particular service. This is quite without obligation. Ask for Form R.

NATIONAL METER COMPANY 299 BROADWAY NEW YORK CITY

The Warwick

The South's
Finest Apartment Hotel

HOUSTON, TEXAS

A RESIDENTIAL location unsurpassed. Only a few minutes to all leading shops and theatres.

Most beautifully situated hotel in Houston. Facing beautiful Hermann Park, assuring an abundance of light and air.

Permanent and Transient arrangements.

Make your Houston home at the Warwick and enjoy the quiet and orderliness of a refined home.

WALLACE C. O'LEARY
President and Manager
PHONE HADLEY 6622

ACROSS from beautiful Hermann Park with its winding drives, shady bridle paths, tennis courts, and golf course. Where gulf breezes keep one cool and comfortable.

Truly a most beautiful spot to spend one's stay while in Houston.

Soda Ash to Brackish Water on the Corrosion of Iron and Steel. Forrest, Roberts and Roetheli. (Paper presented at the Swampscott meeting of the A. C. S., Sept. 1928.) The treatment of brackish or semi-salt water to retard the corrosion of exposed iron or steel structures has been studied. Addition of lime to waters high in bicarbonate and calcium content will cause the formation of protective calcium carbonate scales. Waters containing appreciable quantities of magnesium salts, require soda ash as well as lime treatment to increase the pH and supply carbonate ions before a calcium carbonate scale can be built up. A pH of 8.5 or higher is favorable to the formation of protective carbonate scales. For practical application larger scale studies are recommended to determine the minimum quantity of lime or soda ash nacessary to maintain a thin protective scale on the structure.

OF PARTICULAR INTEREST TO THE CHEMIST

Testing and Analysis

Accuracy of the A. S. T. M. Distillation Method. Bataaf. (Petr. Maatsch. J. I. P. T., 12, 586 (1928). *B. C. A.-B. Mar.* 4, 1927. *p.* 131.) Investigations of thermometer lag with thermometers of different types failed to show any constant difference; results were irregular. Comparisons were made of the results obtained by four experimenters, carrying out five distillations each on four different pieces of apparatus. The smallest variation was in the successive results of one experimenter on the same apparatus, being 1 degrees for initial and final b.p. and 0.2 degrees for the middle distillation range. These errors become 1.3 degrees and 0.4-0.5 degrees when one observer works with various apparatus; and with various observers and apparatus, 1.4 degrees for initial b.p., more than 0.5 degrees for middle range, and for final b.p., 1.30-2.50. The accuracy with which the volume of benzine distilling at a certain temperature is determined is equal to accuracy of temperature reading multiplied by the cotangent of the angle of the distillation curve at that point.

The Reaction of Mercuric Acetate with Olefins. Larson and Morton. (Paper presented at the Swampscott meeting of the A. C. S., Sept. 10-14, 1928.) A series of experiments have been made to determine the optimum condition for the reaction between mercuric acetate and olefins. Best results are secured in glacial acetic acid as a solvent. The measurements are made in a Babcock bottle. The decrease in volume of a solution of the olefin in petroleum ether as compared with a blank is used as the measure of the reaction. Experiments made on eleven olefins indicate that this procedure makes for a great improvement over the results of earlier investigators and may make it possible to use the reaction for analytical purposes.

Action of Sulfuric Acid on Aromatic Hydrocarbons in Connection with their Detection in Gasoline. Tiliche'ev and Dumsku. (Neftyanoe Khozyaistvo 13,647-58 (1927). *C. A. Vol.* 22, *No.* 9, *p.* 1674.) The aromatic compounds investigated were benzene, toluene, pseudo-cumene, tetralin and naphthalene. The gasoline treated with fuming sulfuric acid until no further reaction could be noticed, was added 20 per cent of the aromatic compound and this mixture was treated with sulfuric acid in a quantity equimolecular to that of the aromatic compound. Of the aromatic compounds studied, those that are very resistant to sulfuric acid are benzene, *p*-disubstituted benzenes and tetra-substituted benzenes. All other aromatic compounds present in gasoline are easily sulfonated. The first group is sulfonated by sulfuric acid of 1.84 specific gravity (95.6 per cent monohydrate); the second requires only 91 to 92 per cent sulfuric acid. Fuming acid could not be used, as it reacts with naphthenes.

Symposium on the Determination of

IF
It Is
FORGED STEEL FLANGES
You Want
WE HAVE THEM

IN STOCK
AND IN ALL SIZES

FORGED STEEL VALVES
FORGED STEEL FITTINGS
CAST STEEL FITTINGS
TYCOS INSTRUMENTS
TUBE TURNS
NEILAN REGULATORS

MAINTENANCE ENGINEERING CORP.
1400 Conti St. Preston 2274-5
HOUSTON, TEXAS

HAVING GASKET PROBLEMS?

LET US SOLVE THEM FOR YOU!

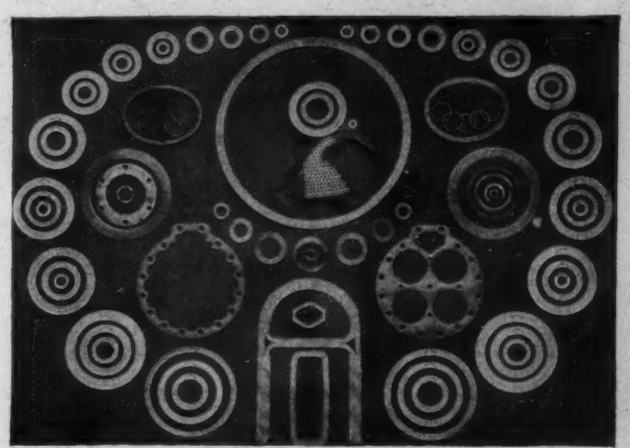
We make metal gaskets of any size or shape, plain or corrugated, with or without asbestos, also plain solid washers of copper, aluminum, monel metal or any material desired. Our Gasket Guide shows a very complete line of gaskets suitable for refinery work.

Copy sent upon request.

GOETZE

GASKET & PACKING CO., Inc.

P. O. Box 175
NEW BRUNSWICK, N. J.



A Few Types of Goetze Gaskets

Refinery Walkway (Type A)

ARROWHEAD GRATING AND TREADS For the Oil Industry

ARROWHEAD GRATING

Type A—For Walkways.
Type H—For Floors.
Type M—Rectangular.

Strong—non-slippable—well-appearing.

ARROWHEAD TREADS

The heavy nosing bar defines front.
The non-slip quality makes them safe.
They bolt direct to stringers.

Write for our Handbook

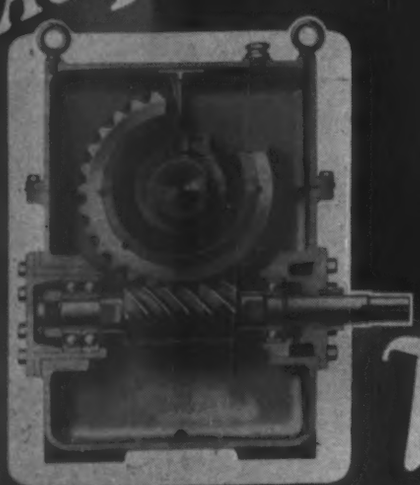
ARROWHEAD IRON WORKS, Inc.

431 West Fifth Street **Kansas City, Missouri**

Mention Where You Saw the Advertisement

De Laval Worm Gear

A Superior Speed Reducer



Where Space is Limited

THIS 60 to 1 ratio gear transmits 15 h.p. from a 900 r.p.m. motor to a billet pusher on a heating furnace.

De Laval Steam Turbine Co., Trenton, N. J.

2995 AD-1013

There are hundreds of uses for Tycos Temperature Instruments in the Oil Industry for it is exceeded by few in the number and diversity of its temperature requirements.

Tycos Temperature Instruments are rendering excellent service to oil operators all over the world. It is with confidence, therefore, that we recommend these sturdy, reliable instruments for *your* refinery.

Our engineers will demonstrate why their uniform results and low upkeep make them worthy of being made the standard at your refinery.

TYCOS Temperature Instruments

INDICATING - RECORDING - CONTROLLING

There's a Tycos or Taylor Instrument for Every Purpose

Taylor Instrument Companies
Rochester, N.Y. U.S.A.
Canadian Plant
Tycos Building, Toronto, Canada

Mention Where You Saw the Advertisement

NEW EQUIPMENT, CATALOGS, BULLETINS, BOOKS

CHICAGA PNEUMATIC TOOL COMPANY

Chicago Pneumatic Tool Company, 6 East 44th Street, New York, has recently extended its line of gas engine driven compressors to include a vertical compressor especially designed for gasoline extraction and direct driven at 228 r.p.m. by a 200 B.H.P. vertical, three-cylinder, four-cycle gas engine.

The engine is directly connected to the compressor by a flexible coupling of the laminated flexible disc type, a drive that has been used very successfully in the oil fields for several years. The fuel consumption of this unit per million feet of gas delivered is surprisingly low, and the range of gases upon which the engine will operate is very wide, including even the more corrosive gases. Special materials of non-corrosive properties have been employed in both the engine and compressor.

The ease of installation, the wide range of cylinder sizes available, and the overall operating economy of the unit recommend it especially for gasoline extraction work, for well-flowing on a large scale, for experimental work involving widely varying pressures, and for general booster service.

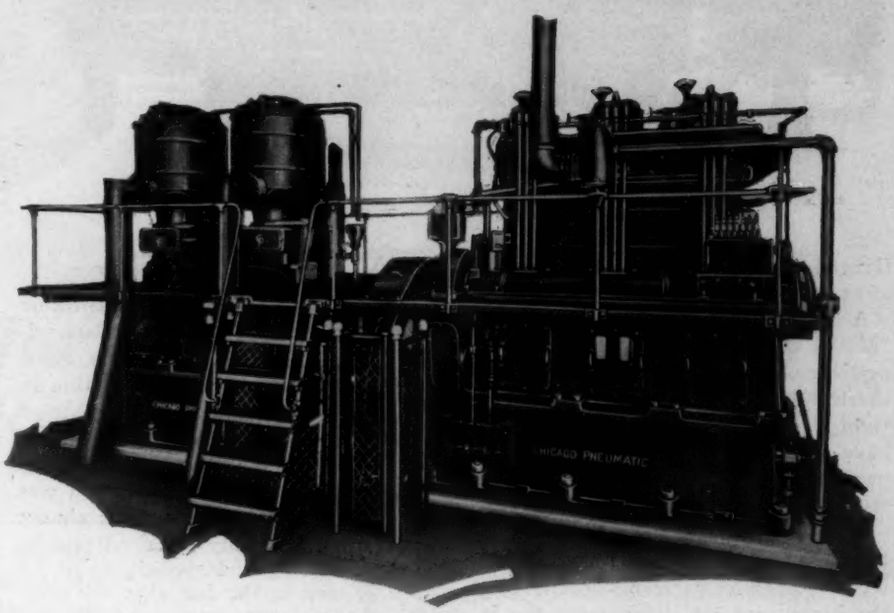
The compressor, which has been designed with special features adapting it to gasoline extraction service, is of the vertical duplex, double acting design for single or two-stage compression to pressures ranging from 30 to 500 pounds per square inch, with cylinder sizes proportioned to absorb the power of the 200 h.p. gas engine.

The compressor cylinders are all fitted with removable liners carried in a variety of sizes to suit every pressure between the limits mentioned. The sizes of the cylinders of any compressor can be changed easily on the job by replacing the liner with one of a different size and with the proper size of piston. Liners can be made of special materials suitable for corrosive gases. Liner joints are sealed at the top by a shoulder which comes flush with the cylinder face. The water space at the bottom is sealed off by a rubber gasket which makes a water tight joint.

All valves are located in the heads of the compressor which are of simple construction. The heads of the larger low pressure cylinders are conical to minimize the clearance when accommodating a wide range of cylinder diameters.

The discharge passages all lead to the bottom of the cylinder to permit complete draining off of all condensed vapors. With this design of cylinders no liquids can accumulate behind a piston, and wet gases can be handled without any difficulty whatever.

Inlet and discharge valves are of the Simplate design which have been successfully used for many years in air and gas compressors under the most strenuous conditions. All valves are accessible and valve assemblies can be removed in a very few minutes. While unloading systems are rarely used on such units, nevertheless, the inlet valves can be of the unloading type adapted to complete any system of regulation that may be desirable.



New Chicago Pneumatic Compressor

The compressor as a whole is exceptionally compact and yet easily accessible. Large frame doors give convenient access to the interior of the frame and crank case for inspection and adjustment. Service platforms with stairs enables the operator to reach all the upper parts of the compressor.

Main bearings are of the shim adjusted Diesel engine type, lubricated by pressure feed as are also the crank pin boxes. The compressor cylinders are lubricated by a force feed lubricator. Connecting rod bearings are wedge adjusted.

The gas engine is a four-cycle design that in reality is a converted Diesel engine. All main parts of the engine are Diesel engine parts, being identical with those of the Type RH-75 Diesel Engine also manufactured by the Chicago Pneumatic Tool Company. Parts are therefore heavily designed for the work to be done.

The most notable features of the engine include removable cylinder liners, full pressure feed lubrication for bearings and two-point, timed, pressure feed lubrication for the cylinders, removable valve cages.

Fuel economy is excellent and regulation is good.

Further information may be obtained from the Chicago Pneumatic Tool Company.

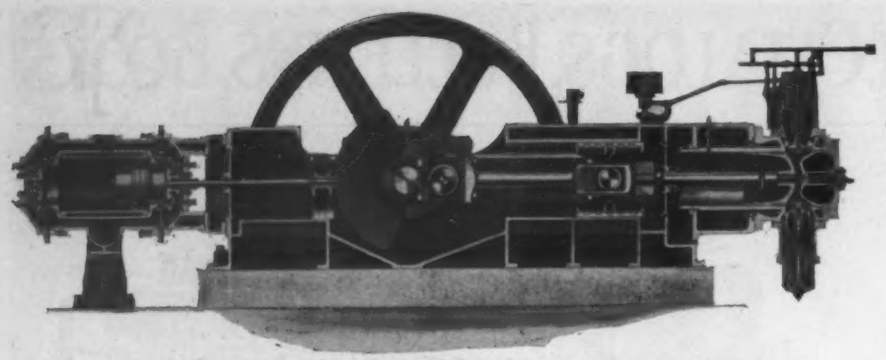
The Lee B. Mettler Company, 821 San Francisco Building, Los Angeles, has recently issued a 24-page catalog on its Entrained Combustion Gas burners. The catalog is fully illustrated with photographs and drawings on tubes and other burner parts and the assembled product working. A complete detailed escription of operations is carried, giving burner size and gas pressure of the new 1929 Mettler burners. An interesting feature is the listing of illustrations of a number of the leading users of the entrained combustion gas burners.

A copy of the catalog will be supplied upon request to the company.

National Transit Pump & Machine Company, Oil City, Pennsylvania, has recently placed on the market its new Transit Gas Engine Compressor, direct connected, opposed type, four cycle, single acting "Model 26." It is a 17x24-inch twin 170 horsepower, 180 r.p.m.

The new "Model 26" is especially designed for compressing natural gas; for either transmission through lines or for gasoline extraction processes. Special arrangements have been made for insuring a thorough mixture of gas and air as each enters the cylinders, resulting in a quick burning mixture, full expansion and the highest efficiency in the use of fuel. Through this work backfiring has been eliminated.

"Model 26" has a single regulating valve, allowing each cylinder to draw its charge under identical conditions, resulting in the work of the two cylinders being equally divided. Thus overloading of one cylinder is eliminated. An interesting feature is the removable



Longitudinal section, Transit Model 26 gas engine compressor.

flanged sleeve permitting the removal of scale easily.

A feature of note in the design of "Model 26" is the fact that, with exception of the main frames and cam shafts, all parts that are usually made right and left hand on a twin engine have been made interchangeable, thus necessitating the carrying of a minimum of spare parts.

One of the usual check valves has been eliminated and the valve opening into the cylinder performs double duty; the same cam which operates the inlet and exhaust valve is also used to operate the air starting valve.

Full details of the new engine are given in a new catalog, which will be mailed upon request to the company.

The Schutte & Koerting Company, Philadelphia, describes its flow indicators for pipe lines carrying oil, water and other liquids in its recent Bulletin 6-F, issued as a supplement to the company's Jet Catalog, Volume 1. A photographic illustrated description of the flow indicator is made in this bulletin and explanation of installation and operation and the standard application for flow indicators are illustrated with simply outlined drawings. A copy of this bulletin is available by writing Schutte & Koerting Company at 12th and Thompson Streets.

The company has also recently issued its Bulletin 12-G as a supplement to its Heat Transfer Catalog, Volume 4, to replace the old 12-G section. The new bulletin serves to describe the surface type coolers and heaters for air and gases. The after-coolers have a wide use in many plants in connection with air compressors. The new 12-G supplement is illustrated with drawings in colors, with performance of the heaters and after-coolers outlined with charts. It is available on request.

L. T. Mart, president of the Marley Company, Kansas City, Missouri, announces the appointment of the Freeborn Engineering Company, Tulsa, as sales representatives in that territory. The Marley Company manufactures equipment used in refining and natural gasoline plants.

Midwest Air Filter

The recent introduction by Midwest Air Filters, Inc., Bradford, Pennsylvania, of the new Midwest type Sinuous air filter represents a reduction in air cleaning cost to as low as one-third of what the original Midwest filter required. That the early cost of cleaning air by mechanical filtration, which was so high as to make the process almost prohibitive, is rapidly being reduced to a point inviting widespread use of air filter is seen in the fact that the original cost was cut to approximately one-tenth with the introduction of the first centrifugal air filter on the market.

The new Sinuous Model S-H, an automatic air filter that is capable of handling air at a higher velocity without an increased resistence, demonstrates a further enlarging of the dust storage capacity, a move which has constantly been under way in the labrynth type of filter medium. Along with this improvement has also come better efficiency in the production of the automatic self-cleaning filters, incorporating more efficient filter media.

The new type Sinuous filter medium produces but one sinuous bend as compared with the old Midwest type which forced the air to change directions from 10 to 20 times in passing through the medium.

General offices and laboratories of Smith & Leslie, will be maintained at Oil City, Pennsylvania, and another office will be in Kansas City, Missouri. This concern was recently incorporated by A. J. Smith, E. H. Leslie and associates for the engineering and construction of petroleum refineries, refinery equipment and natural gasoline plants; and for consultation as engineers and chemists and for other similar service. Dr. E. H. Leslie was formerly with E. B. Badger & Sons Company, Boston, and before that, with the University of Michigan at Ann Harbor. A. J. Smith was formerly with E. B. Badger & Sons Company.

Although the plant and general offices of De La Vergne Machine Company have moved from New York to Philadelphia, the firm still maintains a large staff at the New York branch offices, 100 Broadway.

F. M. Continuous Flammable Vapor Indicator

MINE SAFETY APPLIANCES COMPANY

The Mine Safety Appliances Company, Pittsburgh, Pennsylvania, is featuring a new product, the F. M. Continuous Flammable Vapor Indicator. This is an instrument designed to continuously indicate the degree of inflammability, or proximity to explosive conditions, of combustible gases or vapors liberated in processes such as lacquering, painting, japanning, or so forth, where proper ventilation control is essential.

The F. M. Continuous Flammable Vapor Indicator may be used to advantage in connection with the recovery of solvents such as benzol, gasoline, acetone, lacquer thinners, alcohol and so forth; and otherwise by the petroleum industry in confined spaces where there is danger of explosions from liberated vapors and gases.

In processes such as lacquering, japanning, and painting, the thinner used, when evaporated, may form explosive mixtures with air. Thinner vapors in the absence of proper ventillation may accumulate in drying ovens in dangerous concentrations resulting in violent explosions and loss of life and property. The only way to prevent these dangerous accumulations is to provide sufficient ventilation to keep the vapors or

The Cooke Seal Ring

A Mechanical Device Sealing Any Rotating Shaft in the Stuffing Box and Revolving *with* it.

Applications	*Eliminates*
Ammonia	Packing
Sulphur Dioxide	Leaks
Carbon Dioxide	Expense
Gases	Trouble
Air	Scored Shafts
Water	Hot Boxes
Brine	Shut Downs
Gasoline	Dirt
Oils	Motor Overload
Liquids	Oil Waste
Pressure or Vacuum	90% Friction

Write to

COOKE SEAL RING

DEPT. I

44 NORTH GREEN ST.

CHICAGO, ILL.

Send Today for a Sample of Rex

Here is a sheet packing which I first started to manufacture in this country back in 1907. I have improved it to a point where I can now give it my unqualified approval.

It is made of asbestos and other heat-resisting materials and does not become brittle or deteriorate with age. Soft and pliable, it is easy to handle.

It is ideal against extreme pressures and temperatures of steam, hot and cold water, ammonia, etc.

A postal card request marked for my attention will bring a generous sample.

O. J. Garlock

Crandall Packing Co.

Perfected Packings for Every Purpose

Palmyra, N. Y., Boston, Chicago, Cleveland, Houston, New York, Pittsburgh, Philadelphia, Kansas City, Mo., St. Louis

EDWARD VALVES

"forged steel" for refinery service!

Refinery operations demand valves that will render a most dependable service—that require very little supervision—that will stand up under severe usage and destructive chemical reaction.

Most important is their *full area* and *easy flow*. This is accomplished by the "Y" type construction as shown in the No. 688—one of the popular refinery types.

Edward pioneered the "forged steel" valve—they are today the largest manufacturer—with more types and improved designs—of wider service range.

The necessity for "forged steel" valves is becoming more pronounced as modern refinery processes are demanding higher pressure. This however, is not their only advantage—*Edward "forged steel" valves are outstanding in their greater strength, low maintenance and unusually long service ability.*

And—Don't forget Edward "forged steel" valves are so low in price that you can standardize on them—*you can use them everywhere and save money.*

No. 688—"Forged Steel," screwed bonnet, screwed ends, O. S. & Y., swivel plug seat and disc, 500 Lb. W. S. P.

All Edward Refinery Valves have seats, discs, and stems of EVAL-LOY (stainless steel). This metal adapted by Edward has great strength — hardness and resistance to corrosion.

THE EDWARD VALVE & MANUFACTURING CO.
East Chicago, Indiana

Stocked by
Chapman Valve Manufacturing Co., 115 W. First St., Tulsa
Maintenance Engineering Corp., 1400 Conti St., Houston

Complete line to 1,350 Lbs. W. S. P. Std.

The new Edward Catalog No. 9 illustrates and describes in detail the complete line of forged steel Globe and Angle Stop Valves and Check Valves in both screwed and flanged ends for all service ranges.

They are fully "standardized" throughout, making all valves interchangeable in the same style and size thus reducing maintenance and stock parts. It will pay to buy Edward forged steel valves.

UNION ACME HOIST

Sizes ¼, ½, 1 and 1½ Tons. A Quick Acting Hoist, Light Weight, Easily carried around.

The empty bottom hook can be raised to load by simply pulling slack of load chain.

It can be lowered to load by pulling cord, which releases ratchet, with the other hand pull hook down to load.

Pressed Steel Plate Construction. Heat Treated Cut Steel Gears. Solid Steel Suspension from hook to hook.

New Complete Hoist Catalog now ready. Sent on request.

Union Manufacturing Company
NEW BRITAIN, CONN.

Branch Offices where Stock is Carried
New York City, 26 Cortlandt St.
Chicago, Ill., 25 So. Jefferson St.
San Francisco, 770 Folsom St.
Cincinnati, Ohio, 306 Syracuse St.
Houston, Texas, Mr. I. Van Tassel, 705 First National Bank Bldg.

C. H. Wheeler *of*

SURFACE CONDENSERS
JET CONDENSERS
BAROMETRIC CONDENSERS
OIL VAPOR CONDENSERS FOR HIGH VACUUM DISTILLATION
LEACH FRACTO CONDENSERS AND HEAT EXCHANGERS
RADOJET AIR PUMPS FOR VACUA UP TO 29.95 INCHES
FORCED AND NATURAL DRAFT COOLING TOWERS

C. H. Wheeler Mfg. Co.
19th St., Lehigh and Sedgley Aves.
PHILADELPHIA

PHILADELPHIA

gases so lean that they will not explode; that is, below the lower explosive limit. Too much ventilation, however is uneconomical and costly; hence the need of the F. M. Continuous Flammable Vapor Indicator for proper ventillation control.

Further information on this instrument may be obtained from the Mine Safety Appliances Company.

JOHNS-MANVILLE ACQUIRES CELITE PRODUCTS

Purchase by the Johns-Manville Corporation of the assets and the entire line of products of the Celite Products Company has been completed, as has been announced in financial circles.

Of much interest to all industrial and construction fields, this acquisition enables Johns-Manville Corporation to take another important step in the strengthening of its position as an outstanding factor in the production and sale of insulating and allied materials.

Accordingly, the Celite Products Company now brings to Johns-Manville an annual business of over $4,000,000, in net sales, of high temperature insulation and kindred lines, made from diatomaceous earth,—a fossilized deposit derived from ancient sea life. An even more valuable asset, however, is the Celite holdings of this deposit in California, which is one of the largest known sources of this kind and quality.

In addition to insulating products, the Celite Products Company has been a large producer of filtration materials extensively used in sugar mills, oil refineries, sewage disposal plants, etc.

Celite for Concrete, one of the newer uses of Celite, is already one of the largest developments of this product. Its primary function is that of greatly increasing the workability of concrete.

This business also will be rapidly developed and amplified by the Johns-Manville Corporation.

C. E. George, for many years western manager, American Schaeffer & Budenberg Corporation, has recently joined the sales staff of the Taylor Instrument Company of Rochester, N. Y. He will be associated with the Chicago office, 58 East Washington Street.

Schutte & Koerting Company's Barometric Multi-Jet Condensers are described in a bulletin, No. 5-AA, issued in October. Sizes and capacities with shipping weights are listed in tabular form, typical condenser installations are given with photographic illustrations and the performance data is illustrated by charts. Detailed description of the Barometric Multi-Jet Condensers may be obtained through writing to the company at Philadelphia for Bulletin 5-AA.

Bulletin No. 5-A of Schutte & Koerting is devoted to describing the Low-Level Multi-Jet Condensers with 32 pages of data and instruction given with photos, drawings and charts to illustrate this equipment.

The Merco Nordstrom Valve Company, subsidiary of The Merrill Company, Engineers, has just issued a new catalog, No. 6, listing its valves and lubricants suitable for valve service. It is a profusely illustrated, substantially bound book of 142 pages, containing illustrations and detailed descriptions of many different types of Nordstrom valves, service cocks, parts, accessories and lubricants, together with tables of sizes and measurements and interesting illustrations of installations now in service in gasoline plants, refineries, chemical plants and power plants.

A copy of Catalog No. 6 may be obtained by writing to Merco Nordstrom Valve Company, 343 Sansome Street, San Francisco, or 11 W. 42nd Street, New York City.

Pioneers

IN THE Development of

FORGED STEEL FLANGES

MADE IN HOUSTON

Boiler Flanges
Tank Flanges
Pipe Flanges
RIVETS
Boiler Tubes

HARRISBURG PIPE & PIPE BENDING CO.
OF TEXAS
Sawyer and Winter Sts.
HOUSTON, TEXAS

ESPECIALLY DESIGNED *for* High Pressure Fractionating Towers and accumulators

"You Can Be Sure of Neilan Products"

NEILAN PILOT OPERATED LIQUID LEVEL CONTROLLER No. 95

This Neilan Controller holds the liquid level perfectly at any pressure up to 750 pounds.

The floating valve action gives perfect control whether passing only a slight volume or the full capacity of the valve. Valves do not hunt or work intermittently.

The float shaft turns in ball bearings, which eliminate all friction. The diaphragm valve also is constructed with ball bearings, which eliminate friction, sticking and binding.

The Neilan Controller can be fully relied upon to maintain the liquid level with practically no variation. It will throttle in any position. There is no lost motion nor time-lag in its operation.

For remote control service—will operate the Valve at any distance up to 1,000 feet or more.

Will operate any size valve, under any pressure, regardless of distance or difference in pressure between the inlet and outlet valves.

Made in cast iron and cast steel for working pressures up to 200 lbs., 300 lbs., 500 lbs., and 750 lbs., and temperatures up to 900° F.

NEILAN PILOT OPERATED BACK PRESSURE REGULATOR, No. 47.

Also designed especially for high pressure fractionating towers and accumulators. Will hold a steady back pressure, thus preventing increased or decreased reboiling in the kettles.

Descriptive Bulletins on Request.

NEILAN, SCHUMACHER & CO.

641-651 Santa Fe Avenue, Los Angeles, Calif.

Representatives:

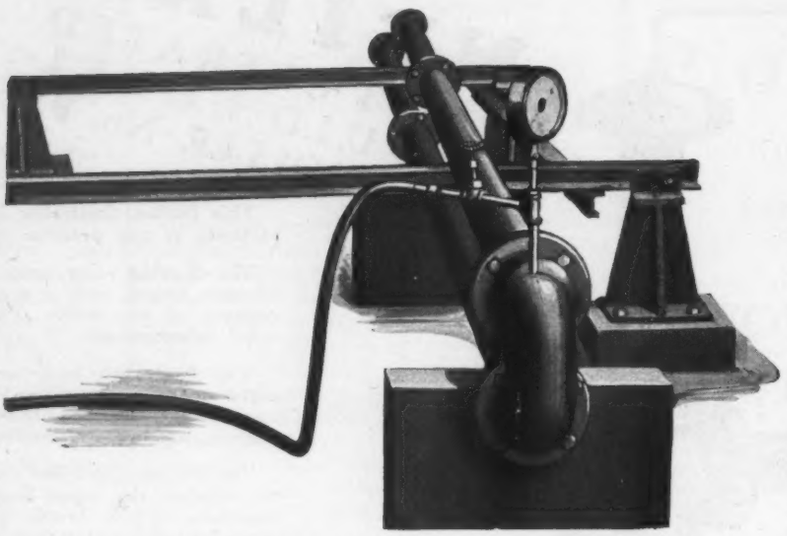
Maintenance Engineering Corp.,
1400 Conti Street,
Houston, Texas
Stocks Carried

NEILAN

C. F. Camp Company
221 East Archer St.,
Tulsa, Okla.
Stocks Carried

Geo. B. Allan & Co.,
Dallas, Texas
Shreveport, Louisiana
Stocks Carried

The Simplex Joint TURNS *or* TWISTS WITHIN ITSELF



This coil has been twisted while under 25 pounds air pressure to demonstrate the flexibility of the Simplex Joint and its peculiar adaptability to this type of construction.

YOU will eliminate costly work and tremendously speed up your condenser coil construction by using Simplex and Plain End Pipe. The Simplex Joint turns or twists within itself—but remains bottle-tight throughout!

The return-bend fittings deflect also. You simply turn the Simplex fitting on the pipe until it reaches the desired angle (see far end of coil in the background of illustration). This feature elminates the necessity of using two ells to make a return when a drop or twist is required.

No specifications need be furnished for beveled flanges, because the Simplex Joint can be assembled with the pipe at any angle required. The movable gland and the bulky gasket allow this deflection and at the same time insure bottle-tightness.

If you want a replacement, you just cut off a piece of Simplex Pipe the length desired . . . using ordinary hand tools in the field!

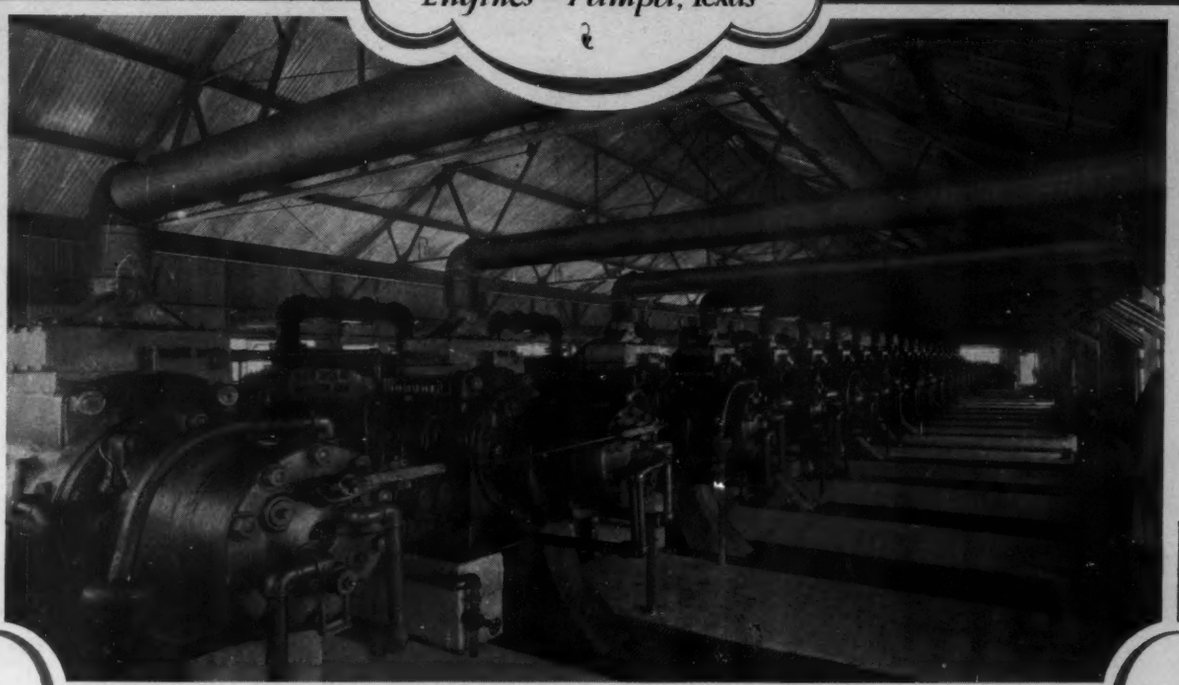
Thousands of installations have proven this pipe adaptable to construction of condenser coils of any type, length, height, or number of runs. It can be assembled by the same crew of men used for flanged pipe work. Write for further details.

AMERICAN CAST IRON PIPE COMPANY

BIRMINGHAM, ALABAMA

DISTRICT OFFICES IN PRINCIPAL CITIES

4,000 H.P. Installation of Double Acting Gas Engines – Pampa, Texas



Obvious Savings Explain the Demand for *Clark Double Acting Engines* –

From the time of its introduction recently, the CLARK Double Acting Gas Engine—which secures a driving impulse in both directions of crosshead travel for every revolution—has been the subject of intense interest and demand on the part of operators because the *savings* effected by such an engine are obvious. This engine delivers twice as much power as an ordinary engine, requires practically the same floor space and weighs much less than an ordinary engine of equal horsepower. The obvious savings effected include a *greatly decreased investment cost per h. p. for engine, foundations, freight and hauling, buildings, and piping for both power and compressor ends.*

Operators familiar with the famous CLARK "Super 2" design also know the great savings in fuel effected by this construction. CLARK Engines using the "Super 2" principle use 1/3 less fuel than the best ordinary 2-cycle engines, because of better mixing, higher turbulence and no loss of gas into the exhaust during scavenging. The large scavenging air cylinder between the two power cylinders gives an amount of scavenging air that insures complete replacement of inert burnt gases by fresh cool air, thus affording greater overload capacity and greater efficiency. CLARK "Super 2" Engines at least equal in efficiency the best 4-cycle engines.

The CLARK Double Acting Gas Engine is simple, rugged and durable. Pressure on crank and crosshead pins are not increased. There are no piston rods in the hot combustion cylinder space. Made in 200 H. P. Single and 400 H. P. Twin types. Ask for complete data. Clark Bros. Company, Olean, N. Y. Branches and Warehouses at 125 W. First St., Tulsa; McCamey and Sweetwater, Texas, and Artesia, N. M. California Branch, Smith, Booth, Usher Company, 228 S. Central Ave., Los Angeles, and 50 Fremont St., San Francisco.

Clark Bros. Co. OLEAN N.Y.

CLARK

Mention Where You Saw the Advertisement

Serving Sinclair

Petroleum engineers the world over have found Byron Jackson Multiplex pumps meet every possible requirement for pipe line and refinery service. This photograph shows Byron Jackson Multiplex pumps at a Sinclair pipe line station at Stroud, Oklahoma, handling 45,000 barrels per day. Similar pumps are used on the 100-mile from Ventura to Wilmington, the longest natural gasoline line in the world. This company's policy of constantly improving its pumps to meet the needs of the petroleum industry accounts for the wide acceptance of our equipment.

SINCE 1872

BYRON JACKSON PUMP CO.

Factories: BERKELEY, Los Angeles, Visalia

Branches: San Francisco, Portland, Salt Lake, Dallas, Phoenix

BYRON JACKSON

CENTRIFUGAL PUMPS FOR EVERY SERVICE

These Tests Tell

Why L&S Portland Cement Paint offers INCREASED surface PROTECTION against Fire, Weather and Water—read below

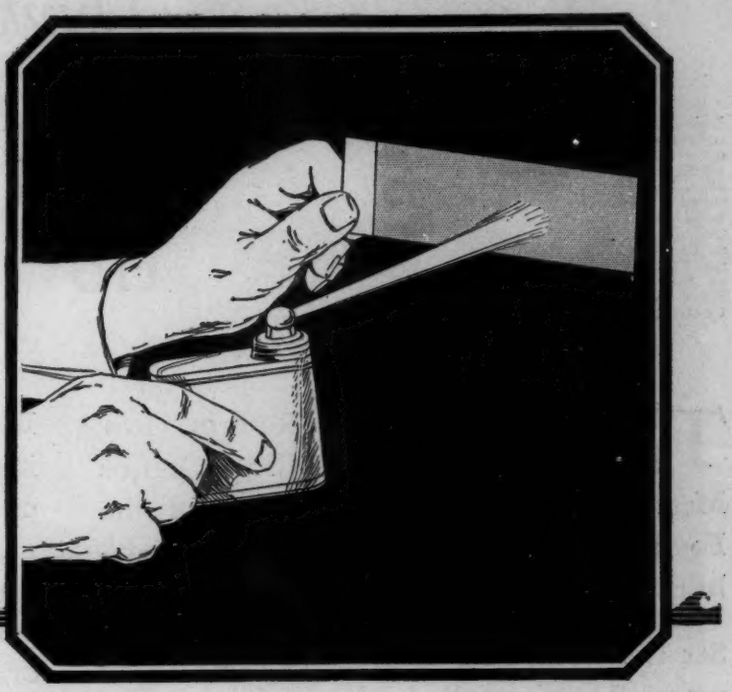


Figure 1

Here is a sheet of black iron coated with L & S Portland Cement Paint and made almost red hot with an alcohol flame. In spite of the terrific heat, the paint does not blister in the slightest degree. No better demonstration could be made to prove toughness and quality.

Figure 2

To further test the quality of L & S Portland Cement Paint, the sheet of black iron, while still hot, is immersed in cold water. This quick change from heat to cold has absolutely no effect upon the paint film.

Firgure 3

Demonstrating the extreme toughness of L & S Portland Cement Paint. Here it has been applied to ordinary galvanized iron sheet metal, untreated in any way before the application of the paint. Note that the metal has been bent double and yet there is no evidence of a crack or fracture in the film of paint.

Figure 4

Burning an ordinary paper clip painted with L & S Portland Cement Paint to show the extraordinary character of the paint film. The paper is quickly consumed, but the paint film remains intact, often in large pieces.

L & S Portland Cement Paint contains Portland Cement combined with other pigments ground in treated oils. The result is a paint with a film so hard that it carries all the virtues of cement, yet retains a high degree of elasticity. L & S Portland Cement Paint produces a close-grained, flat finish of cement-like texture.

L & S Portland Cement Paint is a heavy bodied paint, but it has the easy working and brushing qualities common to high-grade oil paints.

L & S Portland Cement Paint dries flat, with a hard film that will not crack, chip or rub off. It has unusual tenacity and hiding power.

When applied to wood surfaces—wood bridges and trestles, shingle roofs, mine timbers—surfaces that come in contact with electric wiring, etc., L & S Portland Cement Paint greatly reduces the fire hazard.

The extent to which L & S Portland Cement Paint prevents the ignition of wood and other combustible building materials is truly remarkable, and this fire resistance is gained without sacrificing wearing or protective qualities as is often the case with other fire-retarding paints.

HILL, HUBBELL & COMPANY

(Division of General Paint Corporation)

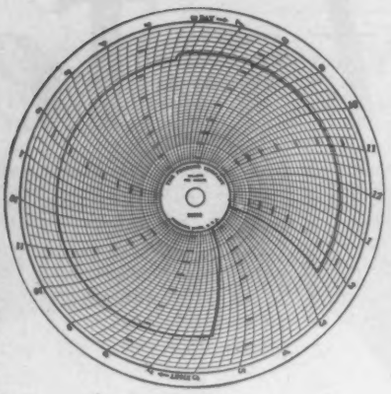
Manufacturers of
Highest Grade Oil Industry Paints and Pipe Line Coatings

Factories: SAN FRANCISCO and TULSA

Offices:

SAN FRANCISCO TULSA NEW YORK LOS ANGELES HOUSTON PORTLAND SEATTLE

Mention Where You Saw the Advertisement



This chart of oil control on a gasoline sweetening plant shows the absolute uniformity of Foxboro Flow Control. This is due to the Full Floating Valve Action of the Foxboro Rate of Flow Controller.

Think what a tremendous advantage it would be to CONTROL the rate of flow in your plant

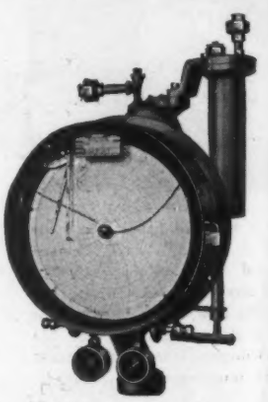
THE Foxboro Automatic Rate of Flow Controller is a Controlling Orifice Meter. It combines the accuracy of the Foxboro Orifice Meter with the dependability of Foxboro Air-Actuated Control.

Set the Controller at the rate of flow you want. The controlled valve maintains that rate of flow either by controlling the speed of the pump or by controlling a valve in the flow line. It is not a pressure controller. It is entirely independent of line pressure. The Foxboro Rate of Flow Controller records as it controls, accurately and instantaneously. You know at any time exactly how much fluid is passing through the pipes.

Foxboro Rate of Flow Controllers are being used throughout the oil industry to control the rate of flow of hot or cold oil, gasoline, sulphuric acid, doctor solution, caustic or any other fluid. In refineries, for example, they are installed on pipe stills, cracking units, shell stills, fractionating towers, bubble towers, lubricating oil treating and blending processes, acid treatment processes and gasoline sweeteners.

Each instrument is fully covered by the Foxboro sealed guarantee.

Write for further details.



Foxboro Rate of Flow Controller

Telechron

Foxboro Recording and Controlling Instruments can be furnished with the Telechron Motor, which insures maximum accuracy of time, perfectly synchronized records, and which eliminates all winding, oiling, regulating and cleaning. Simply change the charts.

THE FOXBORO COMPANY

Neponset Avenue, Foxboro, Mass., U.S.A.

205 So. Cheyenne Ave., Tulsa, Okla.
Magnolia Building, Dallas, Texas
J. E. TREACY, Strada Golesti No. 9, Ploesti, Roumania

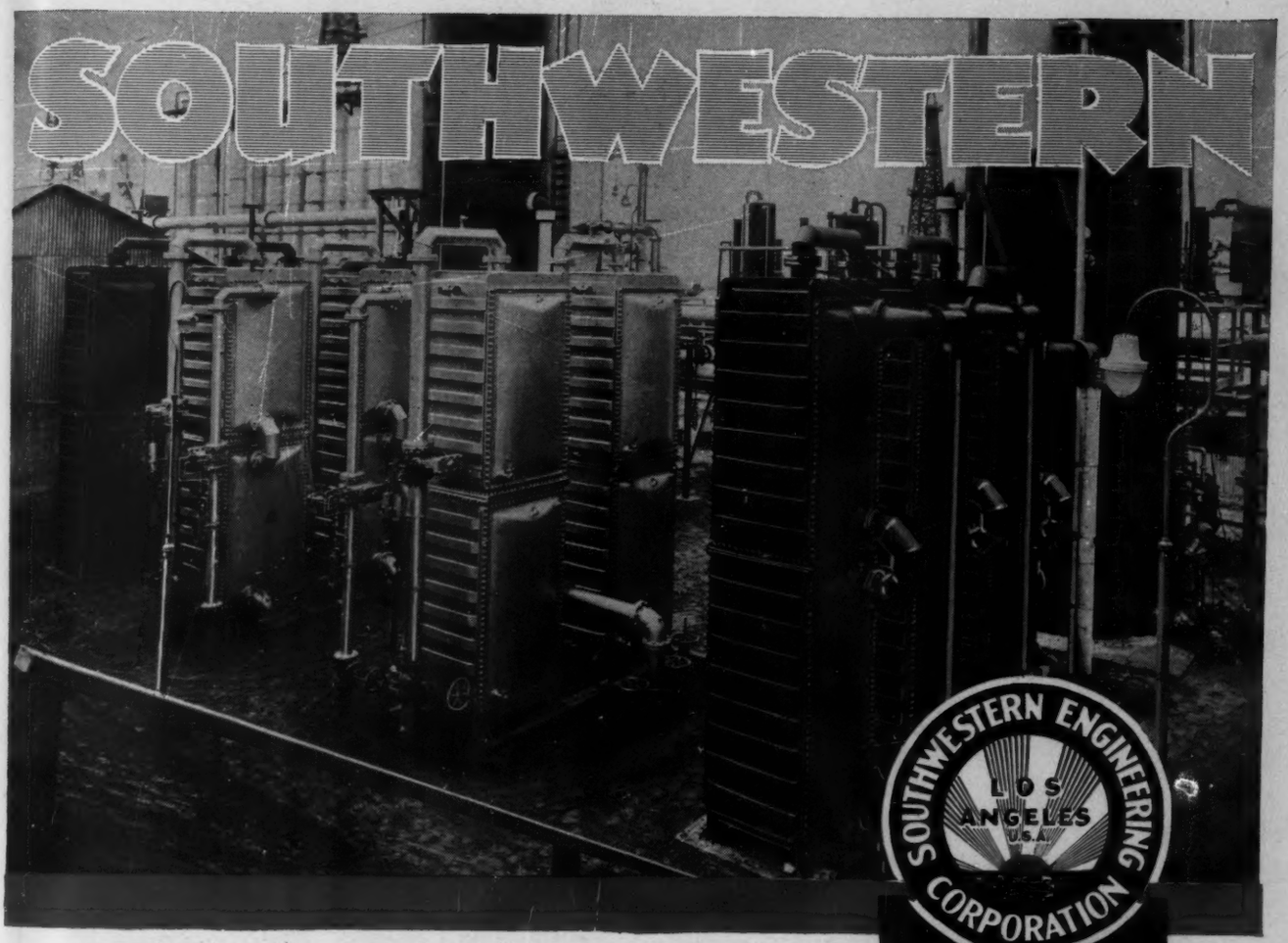
NEW YORK CHICAGO BOSTON PITTSBURGH PHILADELPHIA
CLEVELAND ATLANTA DETROIT ROCHESTER, N.Y. SAN FRANCISCO
PORTLAND, ORE. LOS ANGELES

FOXBORO

REG. U.S. PAT. OFF.

THE COMPASS OF INDUSTRY

INSTRUMENTS *for* CONTROLLING, RECORDING *and* INDICATING TEMPERATURE, FLOW, HUMIDITY *and* PRESSURE



SPECIFY.....

SOUTHWESTERN HEAT EXCHANGERS

For High *and* Effective Heat Transfer..Cast Iron Construction where necessary.

Southwestern design, equipment and construction Oil Coolers in center

Condensers
Heat Exchangers
Gas and Oil Coolers
Fractionating Towers
Absorption Towers
Rectifiers
Tube Stills
Water Tube Boilers

SOUTHWESTERN ENGINEERING CORP.
606 South Hill Street
Los Angeles, Calif.

Branch
605 Mayo Building
Tulsa, Oklahoma

117 Liberty Street — Room 1606 — New York City

Branch
426 Transportation Bldg.
Montreal, Canada

1217 Magnolia Building, Dallas, Texas

Southwestern Engineering Corp.
(At Office Nearest You)

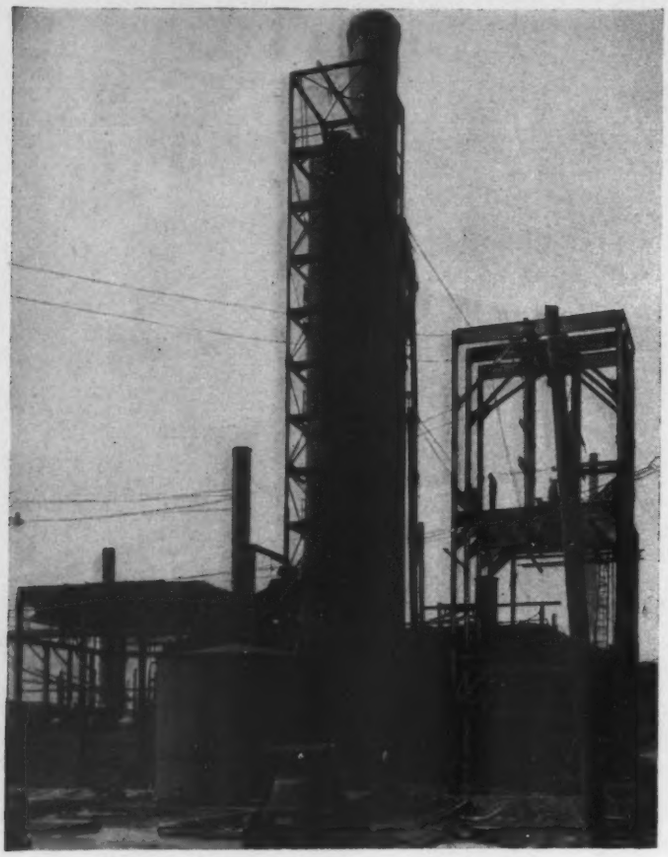
We are interested in Heat Exchangers and Oil Refining Equipment. Please send us detailed information.

Name _____

By _____

Address _____

Mention Where You Saw the Advertisement



Foster Fractionating Towers

The Foster fractionating tower shown above is part of a complete refinery unit designed, manufactured and erected by the Foster Wheeler Corporation.

The charge is delivered directly to the tower from the Foster tube still, and functions both as a vaporizing chamber and fractionating tower. The plates and internal construction are designed for the continuous removal of five streams consisting of overhead vapor stream, three liquid side streams and the bottoms. The side streams from the tower are brought to specification by specially designed control valves arranged to keep a constant ratio of reflux to ascending vapors. The control valve installation is such that the specifications of each side stream can be regulated separately and without changing conditions in other portions of the tower.

The flexible operation of this type of Foster refining unit permits the handling of charging stocks other than that for which it is originally designed.

FOSTER WHEELER CORPORATION

165 Broadway, New York, N. Y.

Branches in Principal Oil Centers

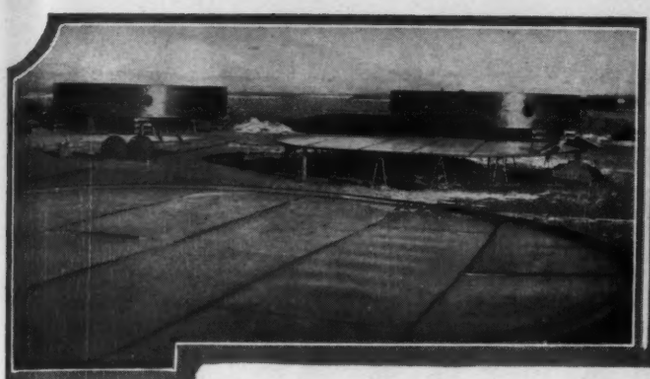
Foreign Associates:—
Foster Wheeler Limited, London, England.
Foster Wheeler Limited, Toronto—Montreal—Vancouver, Canada.

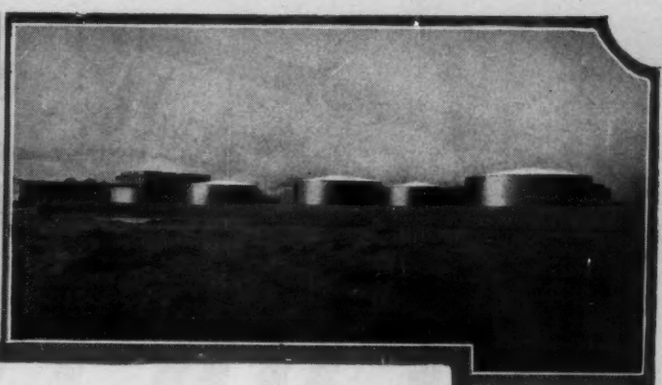
FOSTER WHEELER

FRACTIONATING TOWERS HEAT EXCHANGERS
STEAM JET AIR PUMPS SUPERHEATERS
TUBE STILLS VACUUM PUMPS
WATER COOLED FURNACE SURFACES
BRASS AND COPPER TUBING AND PIPE

AERO UNIT COAL PULVERIZERS
AIR HEATERS CENTRIFUGAL PUMPS
CONDENSERS COOLING TOWERS
ECONOMIZERS EVAPORATORS
EXPANSION JOINTS FEED WATER HEATERS

Mention Where You Saw the Advertisement





"The Sun Never Sets on Hamondtanks"

The "Copyrighted Slogan" tells the story.

In every country where Petroleum Products are stored in steel tanks Hammond Tanks are used.

Steel tanks in capacities up to 100,000 barrels; knocked down or erected.

Oil Refinery Equipment, Stills, Towers, Agitators, etc.

Send for—

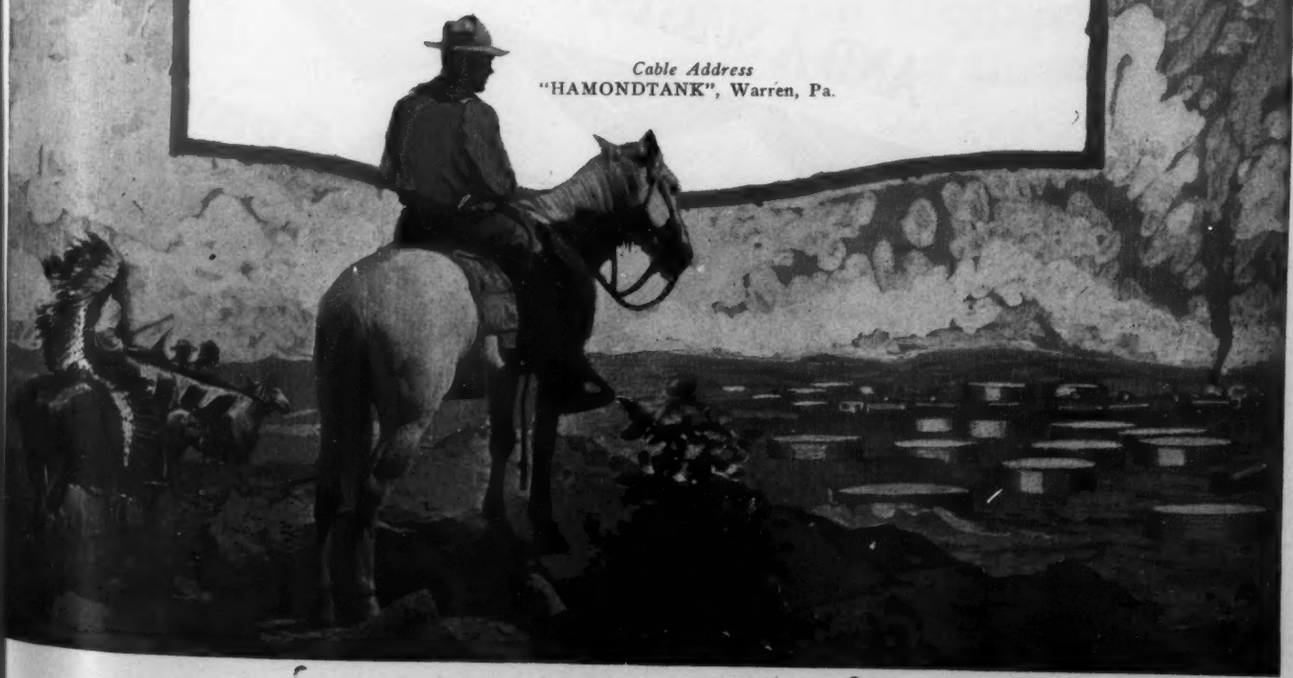
Our Bulletin No. 300—Hammond Filters.
Our Bulletin No. 200—Storage Tanks.
Special Bulletin—Handling and Storing of Fuel Oil.

HAMMOND IRON WORKS

Warren, Pa., U. S. A.

New York Office: 17 BATTERY PLACE
Telephone: Whitehall 0060

Cable Address
"HAMONDTANK", Warren, Pa.



for more economical operation

RECIRCULATION

Will Give You These Added Advantages!

* 1- MILD EVEN TEMPERATURES
* 2- LARGE VOLUME COMBUSTION GAS
* 3- REDUCED MAINTENANCE COST
* 4- INCREASED THRUPUT AND YIELD

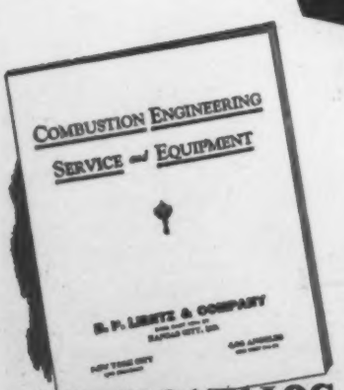
AND A SUBSTANTIAL SAVINGS IN FUEL

B. P. Lientz & Company

ENGINEERS & MANUFACTURERS

Los Angeles KANSAS CITY, MO. New York

Manufacturers of the Lientz Recirculating System, Lientz Oil Burner, Lientz Gas Burner, American Oil and Gas Furnace and Lientz Fuel Oil Pump Sets.



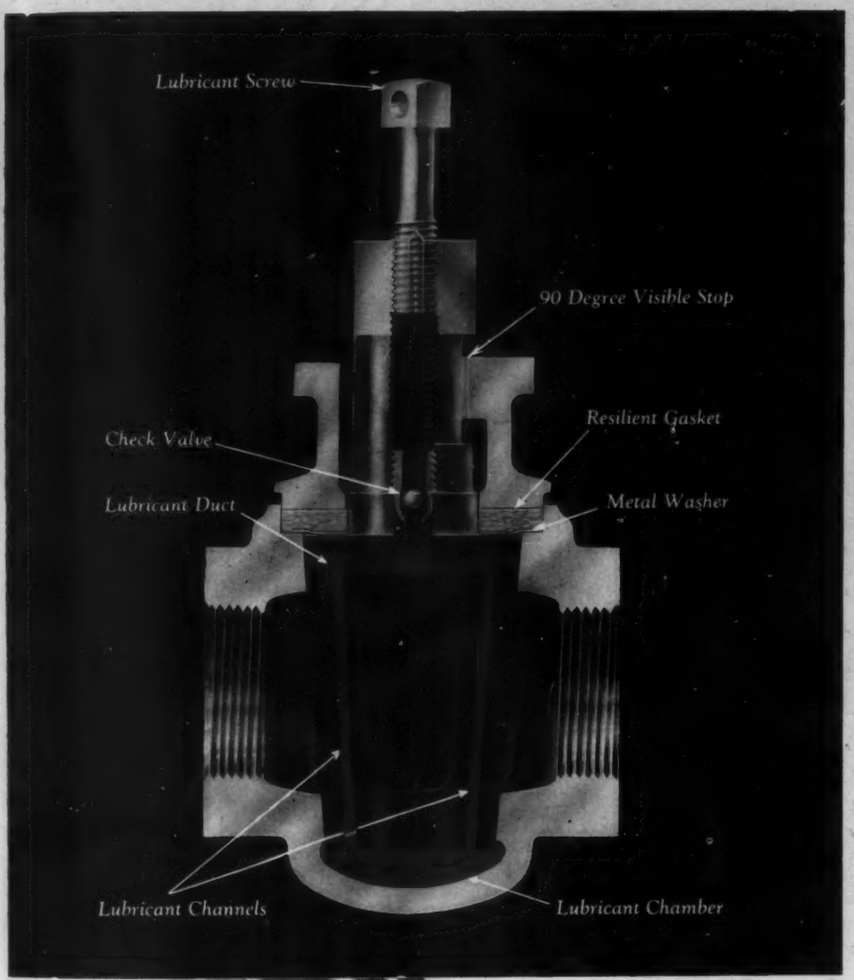
A NEW CATALOG

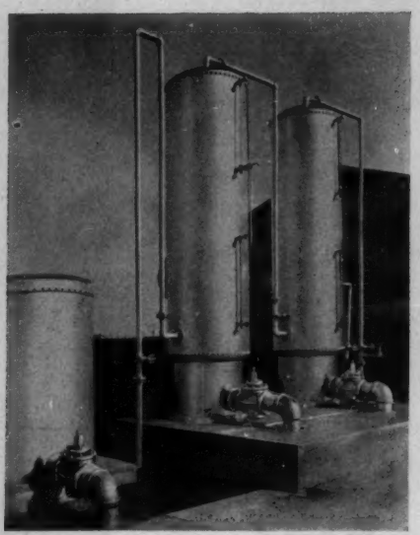
The LIENTZ RECIRCULATING SYSTEM

Mention Where You Saw the Advertisement

Nordstrom Valves

– *the lubricated type for dependable refining service*





SET of three Nordstrom Valves on natural gasoline equipment within plant of a Texas Oil Company

Permanently insure against leaks and stuck valves throughout your plant.

MERCO

Trade Mark

Lubricant displaces force in operation of these Valves

Nordstrom Valves use lubricant under pressure to release the plug against the compression of the gasket and by the same operation thus create a very small space into which a film of lubricant is automatically forced as the plug is turned. The entire operation is simple. A lubricant stick ("Merco" Lubricant) is dropped into the shank of the plug and the lubricant screw turned down on it until the grease in the shank is forced laterally through passages leading to lubricant ducts on either side of the plug. Reaching the base of the plug through these ducts the grease fills a sealed lubricant chamber and exerts an upward pressure on the base of the plug. This releases the plug instantly, should it be tight. WON'T LEAK—WON'T STICK!

Merco Nordstrom Valve Co.

Subsidiary of The Merrill Company

Engineers . . . Manufacturers

Our new Catalog No. 6, completely describing Nordstrom Valves, will be forwarded upon request.

NEW YORK CITY—11 W. 42nd St. CHICAGO—176 W. Adams St. LOS ANGELES—Union Bank Bldg.
BOSTON—184 Boylston St. NEW ORLEANS—Masonic Temple Bldg. SAN FRANCISCO—343 Sansome St.
BUFFALO—Genesee Bldg. HOUSTON—Petroleum Bldg. SEATTLE—Col man Bldg.
CLEVELAND—Engineers Bldg. DALLAS—Magnolia Bldg. AGENCIES—In Principal Cities

Canadian Distributors—PEACOCK BROS., LTD.—Montreal, Que., Cobalt, Ont., Winnipeg, Man., Vancouver, B. C.

FACTORIES: Oakland, Calif., and Belleville, N. J.

Mention Where You Saw the Advertisement

ADAMANT DISTRIBUTORS

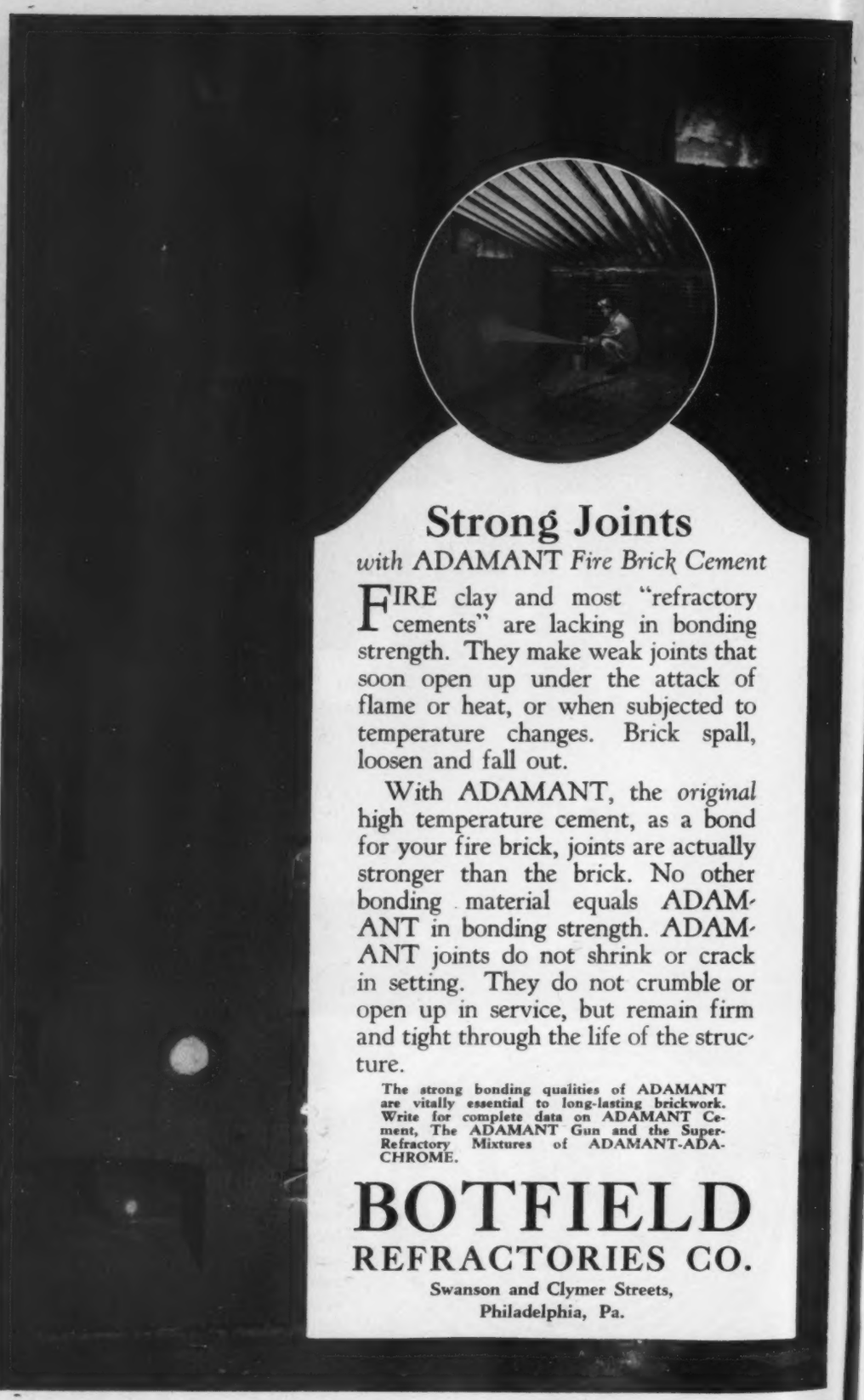
Alabama, Birmingham,
C. B. Davis Engineering Co.
California, Los Angeles
Industrial Supply Co.
California, San Francisco,
W. E. Mushet Co.
Colorado, Denver,
H. W. Thompson
Connecticut, Hartford,
Factory Supply Co.
Connecticut, New Britain,
Buckliffe Bros. Co., Inc.
Connecticut, New Haven,
The Warner-Miller Co.
Georgia, Atlanta,
Atlanta Textile Supply Co.
Illinois, Chicago,
Wm. E. Dee Co.
Indiana, Fort Wayne,
Harry A. Neff
Indiana, Indianapolis,
Indianapolis Belting & Supply Co.
Iowa, Des Moines,
Walrodh Supply Co.
Kentucky, Louisville,
E. D. Morton & Co., Inc.
Kentucky, Paducah,
Henry A. Petter Supply Co.
Louisiana, New Orleans,
Woodward, Wight & Co., Ltd.
Louisiana, Shreveport,
Woodward, Wight & Co., Ltd.
Maryland, Baltimore,
Codd Tank & Specialty Co.
Massachusetts, Boston,
Waldo Bros. & Bond Co.
Massachusetts, Springfield,
Oscar F. Carlson
Massachusetts, Worcester,
Waldo Bros. & Bond Co.
Michigan, Detroit,
H. D. Edwards & Co.
Minnesota, Duluth,
Duluth Builders Supply Co.
Minnesota, Minneapolis,
Northern Machinery & Supply Co.
Missouri, Kansas City,
Union Material Co.
Missouri, St. Louis,
Handlan-Buck Mfg. Co.
Nebraska, Omaha,
American Machinery & Supply Co.
New Jersey, Atlantic City,
Oil Burner Service Co.
New York, Buffalo,
The Curtis Supply Co.
New York, Mohawk,
American Hard Wall Plaster Co.
New York, New York,
C. C. Phillips, 110 W. 34th St.
New York, Rochester,
American Clay & Cement Corp.
Wm. Summerhays & Son
New York, Rome,
American Hard Wall Plaster Co.
New York, Syracuse,
Paragon Plaster Co.
New York, Utica,
American Hard Wall Plaster Co.
North Carolina, Asheville,
Southern Steel & Cement Co.
North Carolina, Greensboro,
Odell Mill Supply Co.
Ohio, Cincinnati,
Wm. T. Johnston Co.
Ohio, Cleveland,
Cleveland Tool & Supply Co.
Ohio, Columbus,
Westwater Supply Co.
Ohio, Dayton,
Klinger-Dills Co.
Ohio, Toledo,
The Builders & Industrial Supply Co.
Oklahoma, Tulsa,
Standard Asbestos & Cork Co.
Oregon, Portland,
The Kline Specialty Co.
Pennsylvania, Bethlehem,
Morris Black
Pennsylvania, Erie,
O. C. Thayer & Son
Pennsylvania, Pittsburgh,
Pittsburgh Supply Co.
Pennsylvania, Reading,
Reading Foundry & Supply Co.
Rhode Island, Providence,
B. & E. Supply Co.
South Carolina, Columbia
Columbia Supply Co.
South Carolina, Spartanburg
Spartanburg Mill Supply Co.
Tennessee, Memphis,
Reed & Duecker
Texas, Beaumont,
Norvell-Wilder Hardware Co.
Texas, Corpus Christi,
San Antonio Machine & Supply Co.
Texas, Dallas,
The Murray Co.
Texas, El Paso,
Geo. S. Thomson Co.
Texas, Houston,
Norvell-Wilder Hardware Co.
Texas, San Antonio,
San Antonio Machine & Supply Co.
Texas, Waco,
San Antonio Machine & Supply Co.
Virginia, Norfolk,
Empire Machinery & Supply Corp.
Virginia, Richmond,
Southern Ry. Supply Co.
Washington, Seattle,
Cragin & Co.
Washington, Spokane,
Consolidated Supply Co.
West Virginia, Charleston,
South Side Foundry & Machine Works
Wisconsin, Milwaukee,
W. H. Pipkorn Co.
Wisconsin, Superior,
The Speakes Company

Canadian Distributors

British Columbia, Vancouver,
B. C. Equipment Co., Ltd.
Manitoba, Winnipeg,
Walter Beiyea & Co., Ltd.
Ontario, Hamilton,
Thomson-Gordon, Ltd.
Ontario, Port Arthur,
Wells & Emmerson
Ontario, Toronto,
J. H. Morrison
Quebec, Montreal,
Alex. Bremner, Ltd.

Foreign Distributors

France, Paris,
Compagnie Technique Des Petroles
New Zealand, Auckland,
Wilton Furnace & Coal Co., Ltd.



Strong Joints

with ADAMANT *Fire Brick Cement*

FIRE clay and most "refractory cements" are lacking in bonding strength. They make weak joints that soon open up under the attack of flame or heat, or when subjected to temperature changes. Brick spall, loosen and fall out.

With ADAMANT, the *original* high temperature cement, as a bond for your fire brick, joints are actually stronger than the brick. No other bonding material equals ADAMANT in bonding strength. ADAMANT joints do not shrink or crack in setting. They do not crumble or open up in service, but remain firm and tight through the life of the structure.

The strong bonding qualities of ADAMANT are vitally essential to long-lasting brickwork. Write for complete data on ADAMANT Cement, The ADAMANT Gun and the Super-Refractory Mixtures of ADAMANT-ADA-CHROME.

BOTFIELD
REFRACTORIES CO.

Swanson and Clymer Streets,
Philadelphia, Pa.

For a Long Furnace Run, Use The ADAMANT *Gun*

ADAMANT
FIRE BRICK CEMENT

Whenever You Use a Fire Brick, Use ADAMANT, *the Original High Temperature Cement*

Now Popular in CALIFORNIA for Hot Oil Service

Straightway Cast-Steel Valve for pressures over 350 lbs., temperatures over 400°. For low pressure work, this same design is available in Semi-Steel.

Made in semi-steel and cast-steel, Homesteads are recommended for pressures up to 400 pounds and temperatures to 750 degrees. Bronze valves for pressures up to 3000 pounds.

HOMESTEAD VALVES

QUARTER TURN VALVES:
STRAIGHT WAY
THREE WAY
FOUR WAY
LUBRICATED TYPE
ROUND OPENING REFINERY

PROTECTED SEAT VALVES:
HYDRAULIC (B & O. PAT.) OPERATING
REMOTE CONTROL
GLOBE
ROSS AIR SHUT-OFF VALVE
HOVALCO BLOW-OFF VALVE

FOR many Eastern refineries Homestead Valves have been a standard of satisfaction for ten years—and longer. Now, in California, Refiners are experiencing Homestead Valve efficiency and capacity for long service.

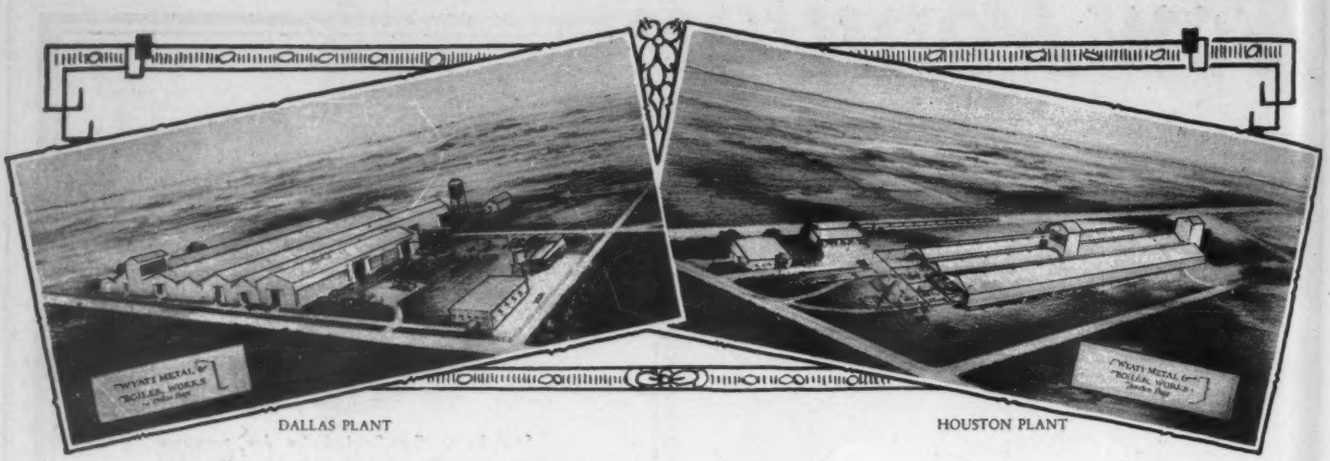
Homesteads have long passed the experimental stages for hot oil, hot tar and other high temperature services. Their position as a high quality and successful valve in the refining industry is established. Recognition extends from coast to coast.

Certain Homestead Valves have been designed with the sole object of standing up and performing for refineries as no other valve has been able to stand up and perform. At least half of all refineries have Homestead valves in one or more services—and usually the installations were made only after these valves had been proved to be superior to the valves that they replaced. The chief applications of Homesteads in this industry are:

High Pressure Valves; High Temperature Valves; Acid Resistant Valves; Vacuum Valves; Boiler Blow-Off Valves; Still Valves; Tar Line Valves; Gas Drip Valves; Wax Press Valves; Receiving Station and Pump House Manifold Valves; Gasoline and Kerosene Line Valves; Vacuum Service.

Examine the complete line of Homestead Valves in our catalogue and allow us to suggest the Valve that will serve your purpose best.

Homestead Valve Manufacturing Company, Coraopolis, Pa.



DALLAS PLANT HOUSTON PLANT

Wyatt Announces Houston Plant

Expansion Program Gives Southwestern Company Equal Facilities With Northern and Eastern Plants

IN keeping with the growing importance of the Southwest as an industrial center and as an industrial market the Wyatt Metal & Boiler Works has started construction of a Houston plant. This plant, with an initial floor space of 75,000 square feet, will be located on the M., K. & T. and Southern Pacific tracks at Washington Avenue.

Wyatt's builds tanks of every character from steel plate, including pressure and storage tanks; refinery equipment; smoke stacks; breechings; air ducts; natural gasoline plants; bulk storage tanks. In addition, the company builds road culverts, road strips and all kinds of galvanized, plain and corrugated metal work.

The Houston plant will be specially equipped with machinery for building the heavy plate work in both riveted and welded construction now required in modern refining practice. Gulf Coast refining interests who have depended upon Chicago, Pittsburgh and Birmingham districts can now be served in the Houston territory.

Additional special equipment will include 36-foot bending rolls, plate planer and G. E. automatic arc welding machines. These machines will build welded steel pipe, cylinders and tanks in 36-foot lengths from a single plate and having a joint of 100% efficiency or equal strength to the solid plates.

Already one of the largest builders of underground storage tanks for filling stations, Wyatt's is installing automatic electric welding equipment to manufacture these tanks entirely by the automatic process.

With its Dallas shops containing 100,000 square feet of floor space, or a total of 175,000 square feet in the two shops, Wyatt's will have capacity for fabricating 25,000 tons of plates and sheets. The two shops will have more than 400 employees and an annual pay roll of $700,000.

WYATT METAL & BOILER WORKS
Capital $1,000,000
DALLAS, TEXAS

Wyatt's

WYATT
METAL & BOILER WORKS

All Around the World

Laclede-Christy Flat Arches for Oil Stills

The photo above shows a big Laclede-Christy Flat Arch at the pier in New York, on its way to the center of the Russian Oil Fields—a nice long boat trip across the Atlantic, over the Mediterranean, up through the Aegaen Sea, past Old Constantinople, then across the Black Sea, landing at Batoum, finally to be hauled across the mountains to Baku on the Caspian Sea in Soviet Russia!

Used by the Largest Refiners on All Types of Stills

LACLEDE-CHRISTY, ST. LOUIS, U. S. A.

M 638

Mention Where You Saw the Advertisement

SILVR-COOL

The Super-Aluminum Paint

The
selection
of Silvr-Cool by
so many outstanding
buyers is the natural result
of its proved quality and economy

Silvr-Cool actually costs you less per year

Write for Silvr-Cool book

DEGRACO PAINTS
All Colors for All Purposes

Detroit Graphite Company
DETROIT, U.S.A.

BRANCH OFFICES AND WAREHOUSE STOCKS IN ALL PRINCIPAL CITIES

FOR HARD SERVICE—

Pittsburgh Seamless

In no other field are steel tubes so subject to the sudden stresses and internal pressure strains of boiler, condenser and still tube usage. Anything but the flawless, forge-finish, uniformly expanding and contracting elastic steel in Pittsburgh Seamless steel tubes is potential trouble—less than good enough for hard service.

There are no pinholes in Pittburgh Seamless tubes—no segregations. They are utterly dependable under strain—fully capable of handling heat and pressure loads at minimum upkeep expense.

Pittsburgh Seamless steel tubes may be had in special analysis and copper-content steels—

FOR ALL IMPORTANT PIPING

Still Tubes Superheater Tubes Boiler Tubes Condenser Tubes
Arch Tubes Water Wall Tubes Steam Lines
Dry Pipes Locomotive and Air Brake Piping Header Tubes
Refrigeration Piping Economizer Tubes Heating Systems
Casing Pipe Lines Drill Pipe Oil Well Tubing Coils
Tank Car Piping Oil and Gas Pipe Lines
Any High Pressure Piping

Sizes up to 13⅜" O. D.—Lengths up to 45 feet

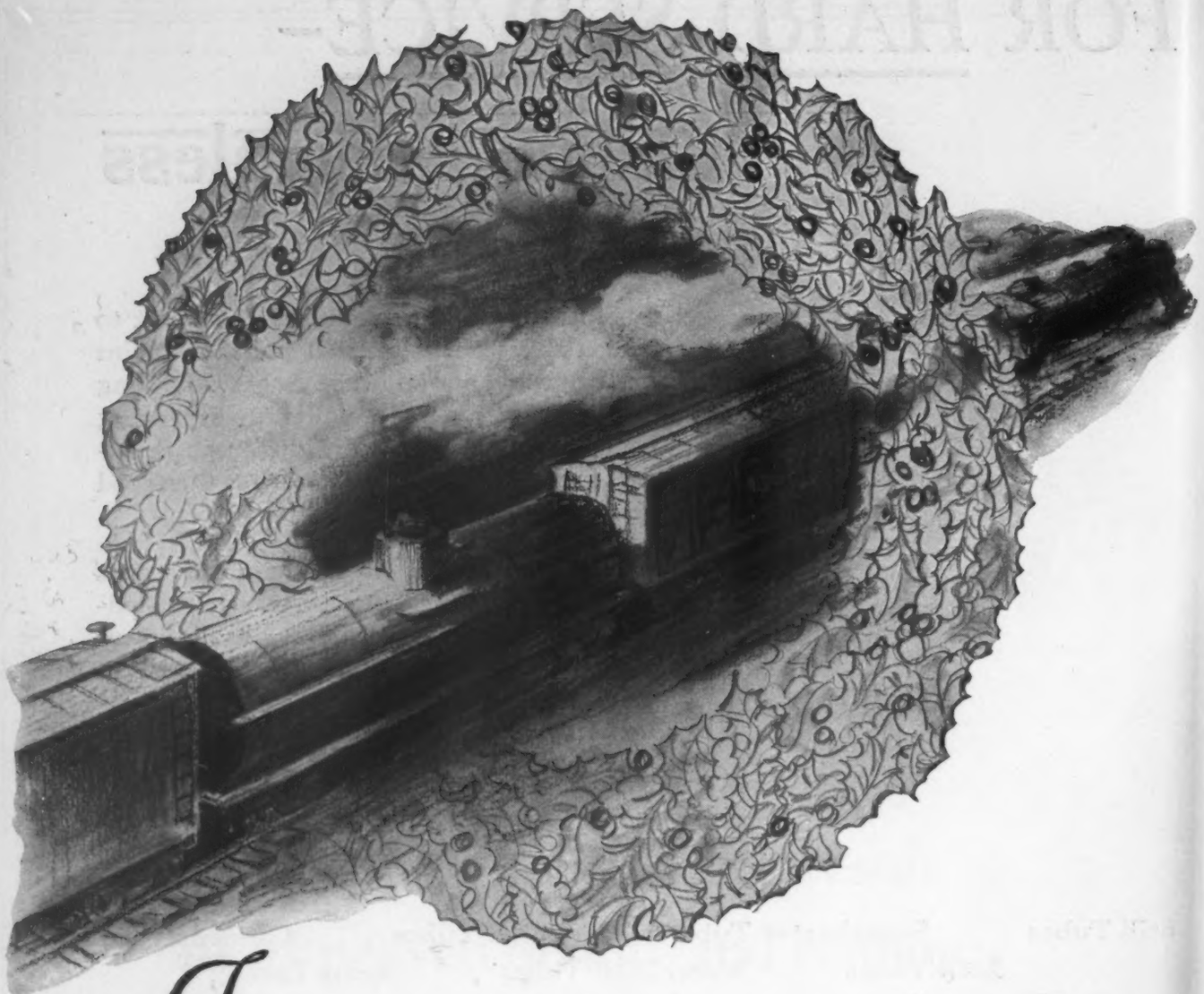
Welded Tubing Seamed

Pittsburgh Steel Products Co.
DIVISION OF
Pittsburgh Steel Co.

Pittsburgh Detroit
New York Houston
Chicago Tulsa

"Pittsburgh Seamless" Safe

Mention Where You Saw the Advertisement



In this, our last message to our Friends in 1928,

We extend our wishes for a

Train-Load

of Peace, Happiness and Prosperity

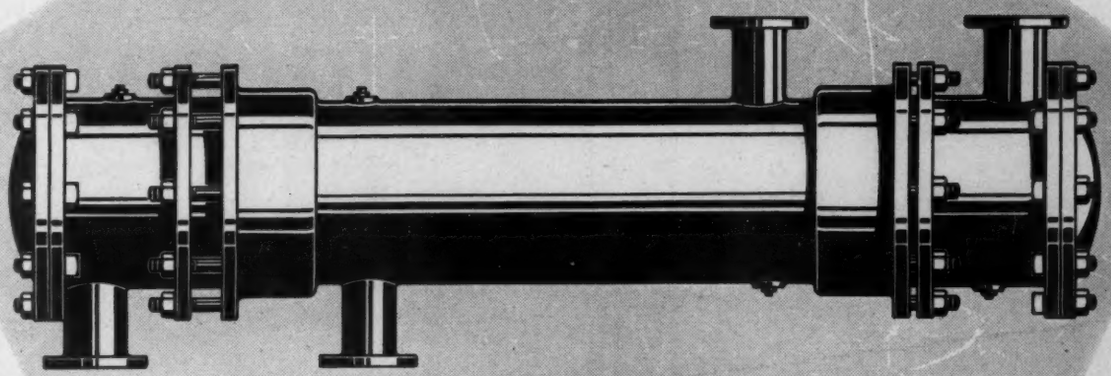
in 1929!

NORTH AMERICAN CAR CORPORATION

Executive Offices · CHICAGO, ILL.

Mention Where You Saw the Advertisement

STRUTHERS-WELLS



Type S L Heat Exchangers

A single pass type with the distinctive Struthers-Wells full floating head construction which permits the tubes and one plate to move freely—thus relieving all strain on the tube joints.

Sizes range from 7 to 5000 square feet—making possible the selection of the right type and size to meet your particular heat exchanger requirements.

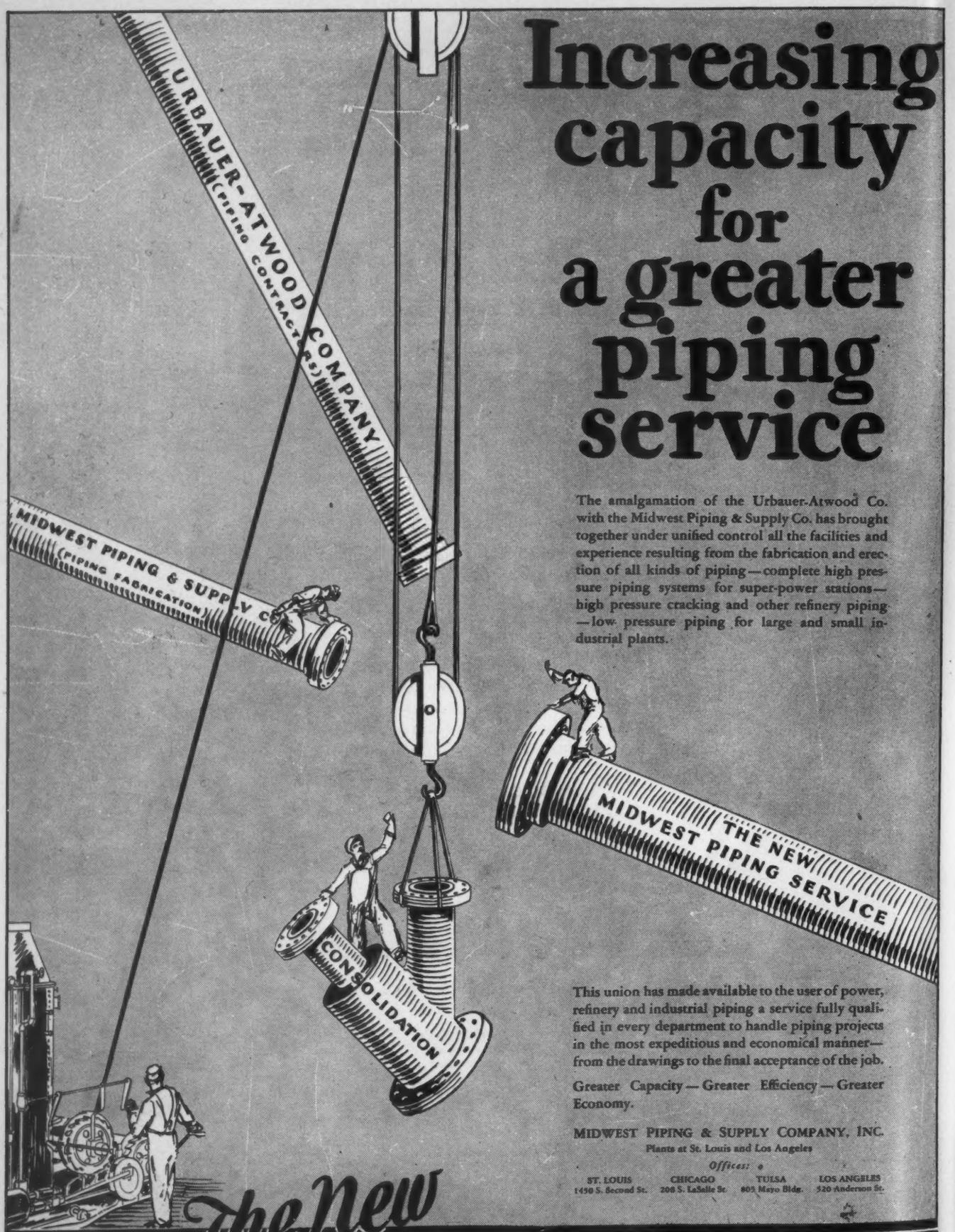
Struthers-Wells Co.
1020 Pennsylvania Avenue
WARREN · PENNA.

A small tube bundle removed from the shell—note compactness and absence of dead spaces.....

Fractionating Towers
Shell Stills
Fullers-Earth Burners
Tube Stills

Filters
Mist Extractors
Agitators
Heat Exchangers
Condensers
Coolers

STRUTHERS-WELLS COMPANY



Increasing capacity for a greater piping service

The amalgamation of the Urbauer-Atwood Co. with the Midwest Piping & Supply Co. has brought together under unified control all the facilities and experience resulting from the fabrication and erection of all kinds of piping—complete high pressure piping systems for super-power stations—high pressure cracking and other refinery piping—low pressure piping for large and small industrial plants.

This union has made available to the user of power, refinery and industrial piping a service fully qualified in every department to handle piping projects in the most expeditious and economical manner—from the drawings to the final acceptance of the job.

Greater Capacity — Greater Efficiency — Greater Economy.

MIDWEST PIPING & SUPPLY COMPANY, INC.
Plants at St. Louis and Los Angeles

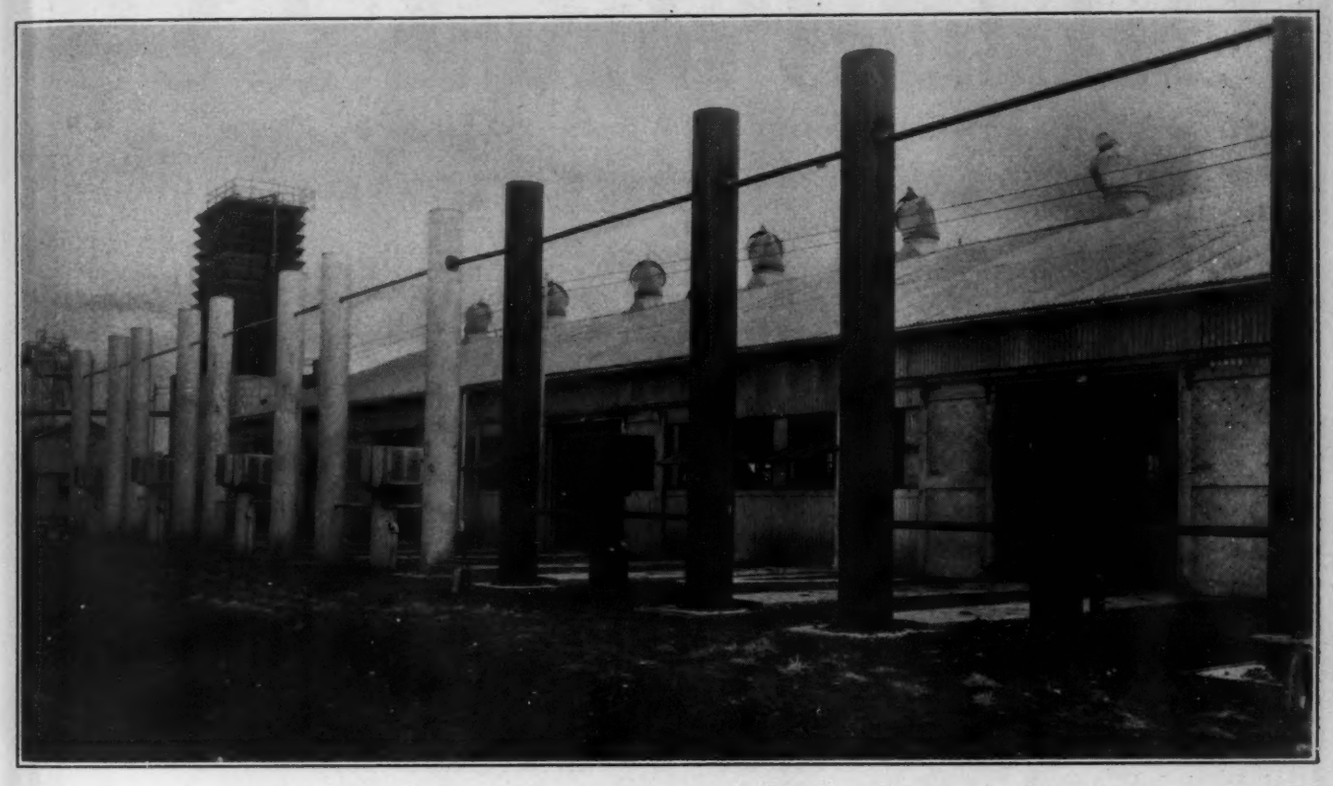
Offices:

ST. LOUIS	CHICAGO	TULSA	LOS ANGELES
1450 S. Second St.	208 S. LaSalle St.	805 Mayo Bldg.	520 Anderson St.

The New MIDWEST Piping Service

Mention Where You Saw the Advertisement

REED AIR IS *CLEAN* AIR



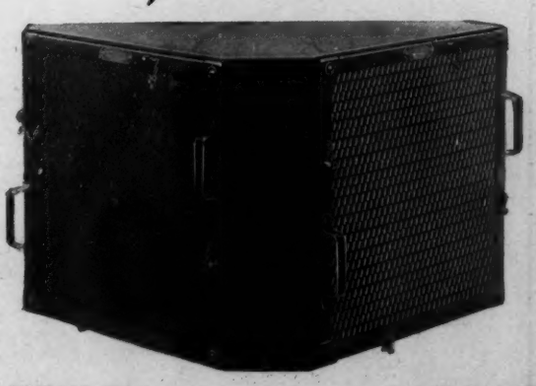
6-three unit type SCF Reed Air Filters furnishing clean air to compressor engines at Gasoline Plant, Roxana, Oklahoma.

Good Business Judgment decides between bad and clean air . . . and chooses . . . **REED AIR FILTERS!**

Big business welcomes improvements. That explains why so many of the larger operating companies have specified Reed Filtered Air for engines and compressors. Clean air reduces maintenance, increases efficiency, promotes longer life—*saves money* Investigate the outstanding advantages of Reed Air Filters. Ask any Smith Separator Company representative or write

Reed Air

TRADE MARK *filters* ALL METAL



REED AIR FILTER COMPANY, INC.
Louisville, Ky.

Distributed by

SMITH SEPARATOR COMPANY
Tulsa *Okla.*

LOS ANGELES SHREVEPORT HOUSTON FORT WORTH

SEAMLESS ENDURO 18-8

18% Chromium 8% Nickel

CRACKING STILL TUBES

Highly Resistant To Corrosive Attack

THE ability of Seamless Enduro 18-8 Still Tubes to withstand corrosive attack, has been proven by many comprehensive tests in actual service.

A number of refineries have installed Seamless Tubes of this material. The tubes have demonstrated unprecedented resistance to the general corrosion—resulting chiefly from the reaction products of salt water and sulphur compounds found in crudes—to which still tubes are subjected. They have eliminated the frequent losses and replacements encountered where tubes of other materials failed from this corrosion.

Moreover, Enduro 18-8 is entirely free from the embrittlement evident in otherwise satisfactory tube materials after protracted service at high temperatures—maintains great strength and is highly resistant to oxidation at high temperatures — is easily worked and is weldable by arc or gas.

Babcock & Wilcox Engineers will welcome the opportunity to present service data and other information relative to the advantages of Seamless Enduro 18-8 Tubes for cracking still service.

Enduro 18-8 is a corrosion resisting and high temperature resisting alloy manufactured by the Central Alloy Steel Corporation, and is fabricated into seamless tubes and pipe exclusively by The Babcock & Wilcox Tube Company.

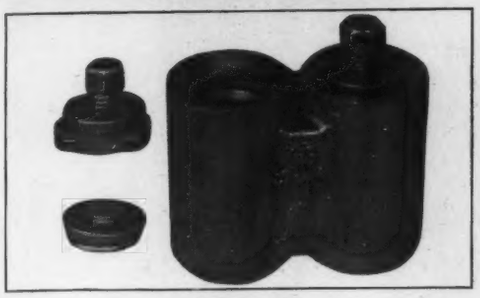
Seamless tubular material and castings of Enduro 18-8 are recommended for use in the following industries: Nitric Acid, Powder and Explosives, Artificial Silk, Pulp and Paper, Food Products, Dyes and Dyestuffs, Oil Refining, Chemical Machinery, and for Condensers and Evaporators.

THE BABCOCK & WILCOX TUBE CO.

Works and General Offices: Beaver Falls, Pa.
General Sales Office: 85 Liberty Street, New York

Amarillo Atlanta Boston Chicago Cincinnati Cleveland Dallas Denver Detroit Galveston Houston Los Angeles
New Orleans Philadelphia Phoenix Pittsburgh Portland Salt Lake City San Antonio
San Francisco Seattle Havana Honolulu San Juan, Porto Rico

THEN OHIOLOCK



Patent No. 1683726

NOW! OHIOLOCK Frictionless

Patent Applied For

Three years ago "Ohio" set a new standard of Return Bend efficiency with the introduction of the "Ohio-Lock."

Now—"Ohio" has contributed another return bend improvement of equal importance—"The Ohio-Lock Frictionless"—a return bend which successfully solves the problem of pressure drop.

This feature combined with the quicker acting Ohio-Lock closure, offers an economical, efficient and safe answer to all return bend requirements.

Notice that the flow area is uniform throughout tubes and fitting as shown by the sectional view. See how it reduces turbulence by permitting constant, unrestricted flow.

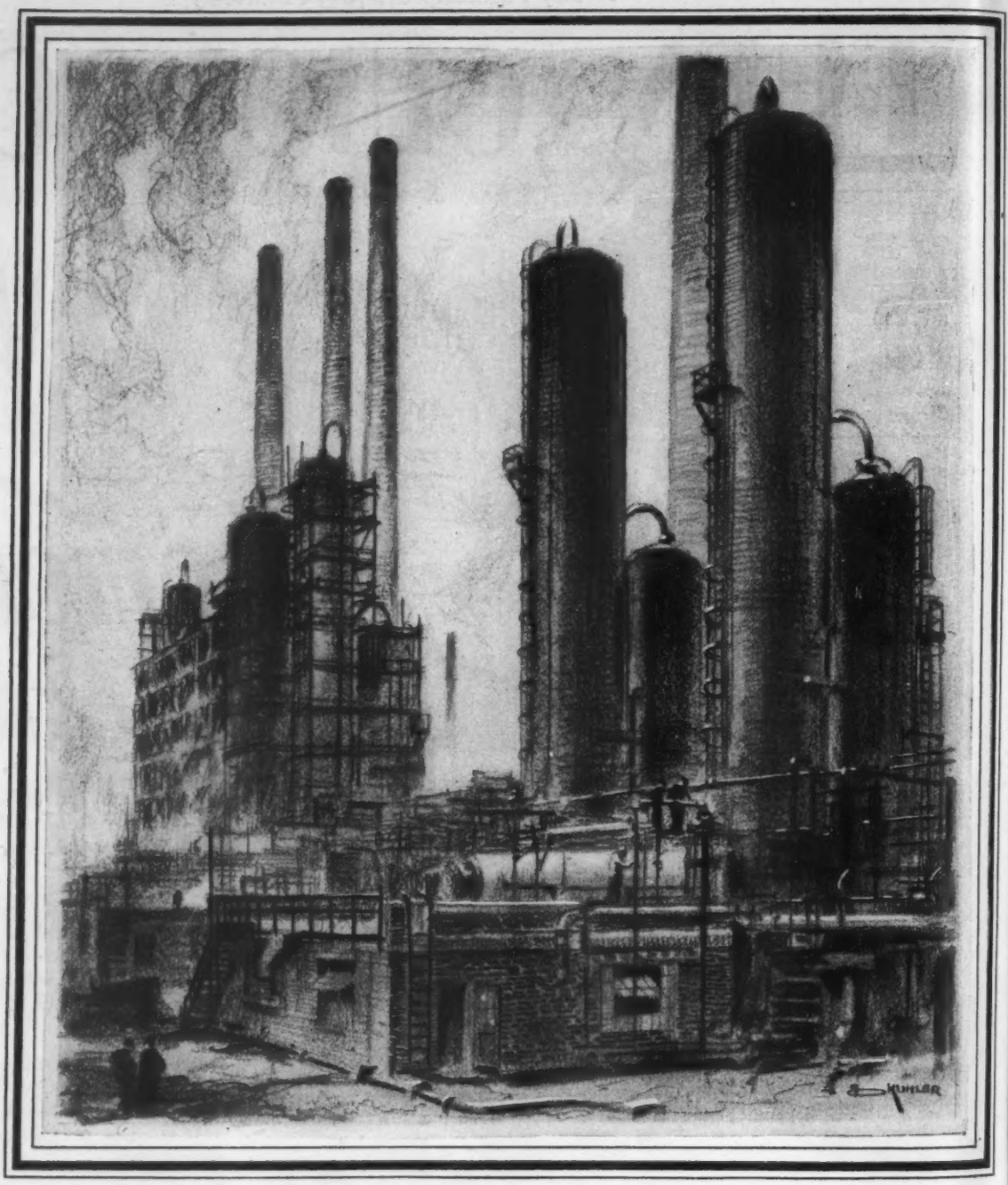
The Frictionless can help you. Write for complete data.

The Ohio Steel Foundry Co.

Springfield, Ohio

Sales Offices:
Detroit—8735 Dexter Blvd.
New York—75 West Street.
Philadelphia—22 W. 15th Street.
St. Louis—1005 Federal Commerce Trust Bldg.
Los Angeles—129 West Second St.
Tulsa—422 Wright Bldg.
Houston—410 Union Nat. Bk. Bldg.

Plants in
SPRINGFIELD
LIMA



REFINERY CONDITIONS ARE ALWAYS DIFFERENT HENCE REFINERIES MUST BE TAILOR-MADE

Nature produces crudes in endless variety. Each one has a combination of characteristics exclusively its own. An accurate fore-knowledge of the peculiarities of the crudes to be handled should always precede the designing of refinery equipment.

Kellogg oil technologists possess an experience with crudes from the oil fields of the world, and have at their command laboratory facilities for making actual runs of any oil. Kellogg refinery equipment is tailor-made, with exact fore-knowledge of the service that it will render.

The M. W. KELLOGG COMPANY

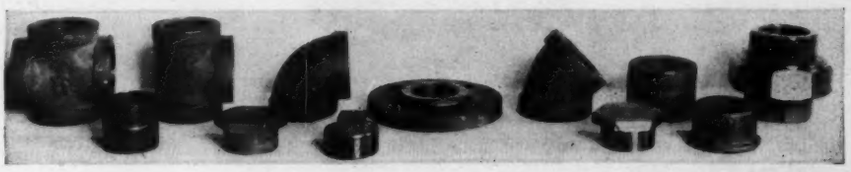
7 DEY STREET, NEW YORK

HOUSTON, TEXAS, 1514 PETROLEUM BLDG. SAN FRANCISCO, CAL., 444 MARKET STREET

LOS ANGELES, CAL., 329 PETROLEUM SECURITIES BLDG

A large oil company gave us this order for acid-resisting★ fittings:

109—4″ flanged elbows
26—3″ flanged elbows
30—4″ flanged tees
10—3″ flanged tees
6—4″x2″x4″ flanged tees
9—4″x4″x1½″ flanged tees
8—3″x3″x¾″ flanged tees
1—5″x4″ flanged reducer
1—4″x3″ flanged reducer
2—¾″x¼″ reducing bushing
64—¾″ screwed elbows
32—1½″x¾″ reducing elbows
22—¾″ screwed tees
8—¾″ screwed stop cocks
2—¾″ screwed crosses
2—3″ pipe plugs
9—4″ pipe plugs
66—4″ companion flanges
48—3″ companion flanges
8—¾″ companion flanges



★ EVERDUR FITTINGS resist corrosion

Try them in liquid and gas lines

BULLETIN 7-E GIVES COMPLETE INFORMATION

SCHUTTE & KERTING

1253 North 12th Street, PHILADELPHIA, PA.

CONTROL STEAM
and
SAVE FUEL
via
Campbell Engineering Products

The above is the "Watermelon Type" of Campbell Steam Flow Controller used so successfully on oil stills.

Controls steam flow, records the flow, and gives direct reading, all at the same time.

Used by many of the foremost oil refineries in the country.

Full information on request.

During the past year these principal Campbell Engineering Co., products have been described in detail in the Refiner & Natural Gasoline Manufacturer. The Editor of this publication has spoken favorably of Campbell products in his columns.

Every oil still should be equipped with a Campbell Steam Flow Controller. It is a money saving device. It indicates the rate of flow and, where desired, records the flow in pounds per hour. The operator may vary the rate at will. Construction is rugged. Easily installed. Easily understood by the operator. Capacity of the still is increased.

It is also usable on other process work—for regulation of steam flow wherever there is pressure drop.

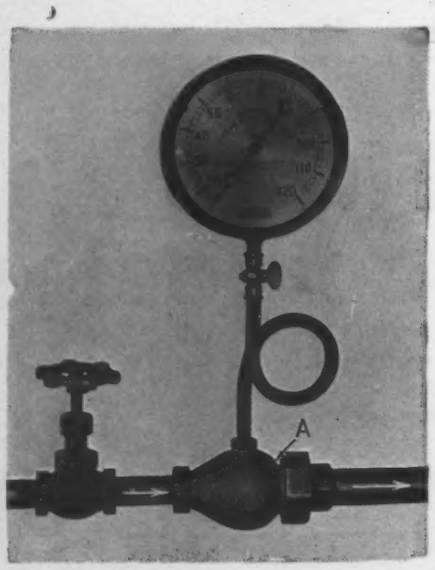
Govern Pump Discharge

For example, we furnish special controlling devices to govern pump discharge as to quantity of flow or pressure. Full information on request.

Steam Main Drainage

The same principle used in the Campbell Boiler Feed Water Regulator—as made and sold by the Atlas Valve Co., Newark, N. J.—may be applied to different high pressure drainage of steam mains.

Careful tests in oil refineries have proven that the Tar Baby Oil Burner is exceptionally efficient for burning water gas tar, fuel oils, acid sludge, and heavy residue fuels.
Full information on request.



This is the "Pumpkin Seed Type" of Campbell Flow Controller which we recommend for smaller rates of flow. It, also, can be furnished in the recording type. Full information on request.

Tar Baby Oil Burner

In the May, 1928 issue, we devoted a whole page to this excellent burner which has fully demonstrated overall economy. It has proven its value and efficiency for burning fuels where other burners have not been satisfactory.

The Tar Baby Burner assures rapid ignition, complete combustion, reduces flue gas temperature, reduces upkeep cost, and increases plant capacity. Efficient, Economical. Adjustable to a wide range of capacity. Easily installed. Let us send you one on a trial order. Write for prices and discount.

Fill in, Tear off, and Mail

The CAMPBELL ENGINEERING CO.
Short Hills, N. J.

Without obligating us in any way, please send information on ( ) the Watermelon Type Controller, ( ) the Pumpkin Seed Type, ( ) the Tar Baby Oil Burner, ( ) The Special Pump Discharge Controller, ( ) Steam Drainage.

Name.....

Firm.....

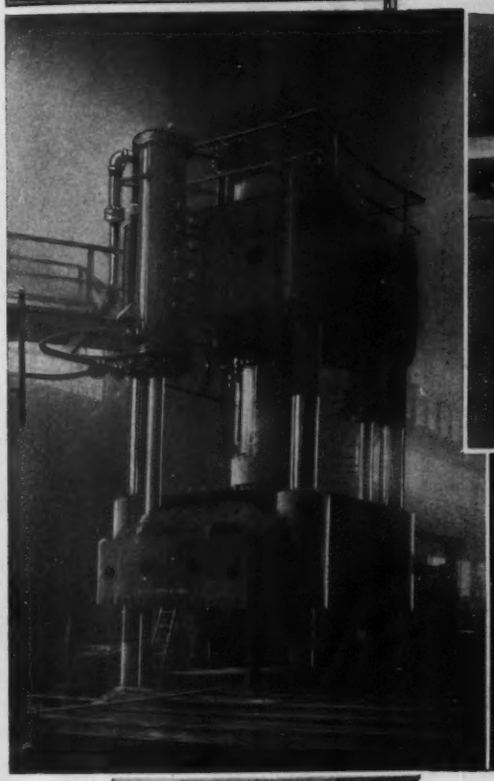
Address.....

.....

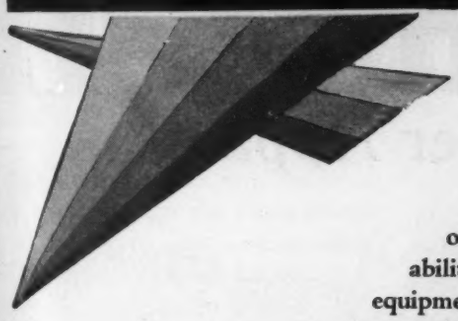
Campbell Engineering Co.
Short Hills, N. J.

Manufacturers of the Tar Baby Oil Burner, Campbell Steam Flow Controllers, and Special Controlling Devices.

MAKING FLUID-FUSION WELDED STILLS



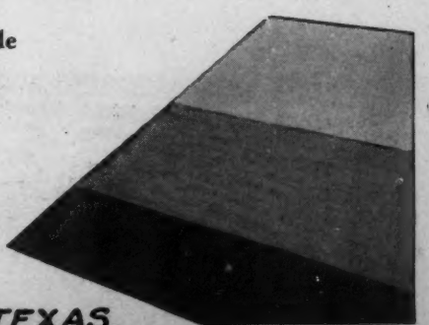
P.I.W.
STEEL PLATE CONSTRUCTION



The exclusive, advanced welding process used in the manufacture of Fluid-Fusion Stills is not the only operation which would baffle the ordinary still manufacturer. The pressing, shaping, and handling of the huge plates, sometimes 6 inches thick, which form the walls of Fluid-Fusion vessels, would be entirely beyond the ability of the average equipped manufacturer. Special equipment is required to handle these operations just as an exclusive and radically different welding process is required to join the heavy plates.

New high pressures and temperatures are possible with Fluid-Fusion stills because these vessels are the result of exclusive processes and special equipment directed by expert engineering toward the task of manufacturing superior pressure vessels.

The nearest P. I. W. office will gladly consult on your pressure problem.



BRANCH PLANT — BEAUMONT, TEXAS.

THE
PETROLEUM IRON WORKS
COMPANY
SHARON, PA.

NEW YORK
CHICAGO
HOUSTON
TULSA

Scale-Shedding!

The G-R Bentube Section

(Patented and Patents Pending)

AN atmospheric cooler that cracks off scale formed on the outside of the tubes by the pronounced bowing of the tubes on change in temperature.

This scale-shedding action keeps the scale from building up to a thickness that will reduce the heat transfer rates below those for which the cooler is designed, and is effective even with poor quality cooling water.

THE GRISCOM-RUSSELL COMPANY
285 Madison Ave., New York
Branches in Principal Oil Centers

PATENT NOTICE
The G-R Bentube Section is fully protected by U. S. Patent 1,617,083

HEAT EXCHANGERS
CONDENSERS
Sub-cooling—Partial—Reflux
Shell-and-Tube, Atmospheric, and Condenser Box Types
COOLERS
Liquid—Gas—Jacket Water
Shell-and-Tube, Atmospheric, and Condenser Box Types
OIL HEATERS
LEVEL CONTROLLERS

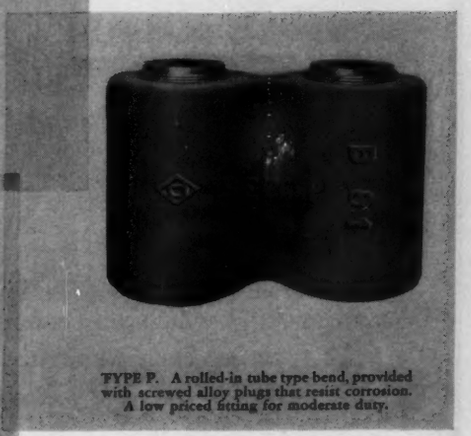
Griscom-Russell
Heat Transfer Apparatus

SECO RETURN BENDS

TYPE A (Patented). A stream-line flow return bend, locked to the tubes by split annular keys. Easily installed or removed for tube cleaning, inspection or replacement. Designed for any operating pressure or temperature.

T-TYPE C (Pat. Pend.). A rolled-in tube type return bend, fitted with ground joint deflector plugs. The stream-line interior minimizes friction.

TYPE T (Patented). A bent tube fitting, employing split annular keys. Designed for extreme pressures and temperatures.



TYPE P. A rolled-in tube type bend, provided with screwed alloy plugs that resist corrosion. A low priced fitting for moderate duty.

SECO Return Bends are made in four types to meet the requirements of various pipe still and cracking still design. They are supplied in tube sizes and center to center distances as specified, and for any operating pressure or temperature. With this complete line of fittings available, you can select a return bend that exactly meets your purpose.

SECO Bends are designed by an experienced engineering organization. Their special features are amply protected by basic patents owned by the company, so that their design need not be a compromise to avoid infringement of other patents.

SECO Bends are made in two modern shops, and recently increased manufacturing facilities assure sound, accurately machined fittings and prompt delivery in any quantity.

Tubes, machined to dimensions, and header plates can be furnished with the bends. Thus, material for the complete coil can be ordered under one contract, with the entire responsibility for satisfactory performance resting on one Company.

Complete data and specifications on return bends, tubes and coil assemblies will be furnished without obligation. Address your request to the nearest office.

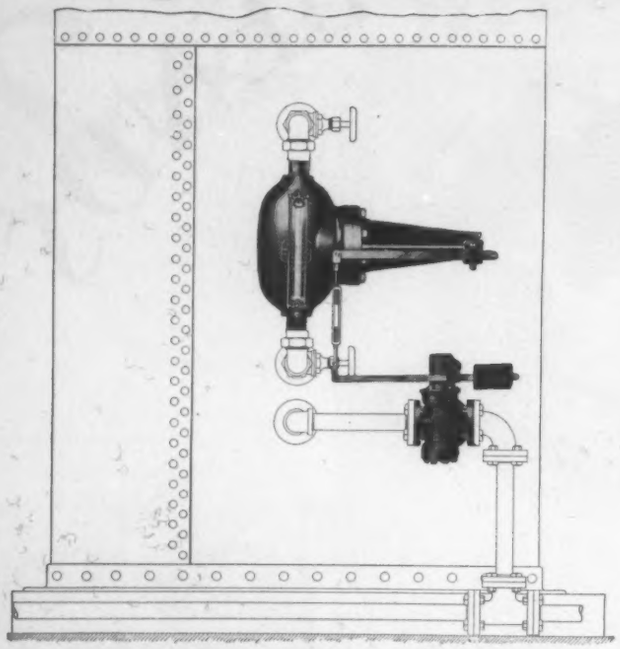
SECO RETURN BENDS

Omaha Steel Works Company
48th and Leavenworth Sts.,
Omaha, Nebraska

Smith Engineering Company
107 West Linwood Blvd.,
Kansas City, Mo.

Dodge Steel Company
6501 Tacony St.,
Philadelphia

Dependable Liquid Level Control



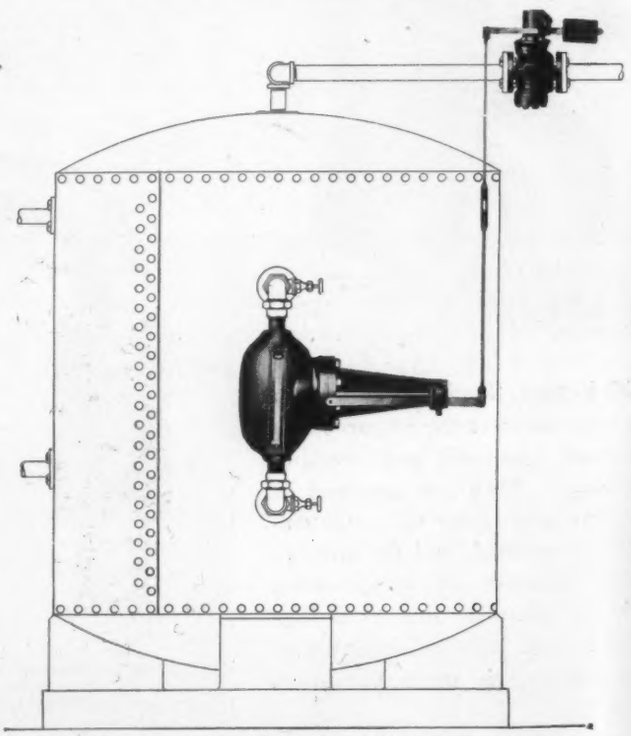
Installation of a Mason No. 290 Liquid Level Controller on an absorber tower.

Where it is inadvisable to place the float inside the liquid container the Mason Liquid Level Controller maintains any predetermined level in stills, receivers, absorber towers, heaters, condensers, closed tanks, etc. It is built to control gasoline, oil, water and other fluids and is often used as a drainer in handling large volumes of condensate from evaporating plants, heaters and condensers requiring a valve of large port area. The leverage of the rotary balanced valve has been considerably increased, making its action more positive, and sticking which was common with the yoke type has been eliminated.

Sturdily built, the Mason No. 290 Controller is unusually sensitive in its action and the slightest change in liquid level causes the float to rise or fall, opening or closing the balanced valve.

Furnished with special trim for corrosive liquids or gases when necessary.

Write for a copy of new Bulletin 290 which gives a complete description of the installation, operation, and maintenance of this Controller, together with prices, weights and roughing in dimensions.



Installation of a Mason No. 290 Liquid Level Controller on a fat oil weathering tank.

Mason Regulators

MASON REGULATOR CO.
Boston, Mass.

Atlas Supply Company
Muskogee, Oklahoma

J. A. Rossiter Company
Houston, Texas

Warren & Bailey Company
Los Angeles, California

Pelican Well, Tool & Supply Company
Shreveport, Louisiana

National Airoil Burners

Patented
Dec 31, 1918
Dec. 12, 1922
Apr. 15, 1924

For Power Plants and Stills and all Industrial Furnaces

NATIONAL AIROIL BURNERS
are internal atomizing burners—inside mixers —operating with either steam or compressed air; and burn as steady as a gas flame with any grade of fuel. Set your fire the way you want it, and it will burn the day through without watching or readjusting.

NATIONAL AIROIL BURNERS
will handle the heavy residuum from cracking stills without requiring continual removal for cleaning, an immense factor in economical plant operation.

NATIONAL AIROIL BURNERS
when operating under boilers will use less than one per cent of the steam for atomizing the oil. The old style steam atomizing burners use from three to seven per cent.

NATIONAL AIROIL BURNERS
give a soft gaseous flame that does not injure brick work or boiler tubes. Made with flat or round tips.

Write for our Bulletin No. 21

National Airoil Burner Company

Factory: S. W. Cor. 9th and Thompson Sts.
Sales Rooms: 1327 Girard Avenue
PHILADELPHIA, PA.

Oil Burners and Oil Burning Equipment

STOCKHAM FITTINGS

for all Oil Country requirements

PIPE fittings for oil production and refining are often subjected to severe shock and strain—repeated expansion and contraction—extreme temperatures. Oil country fittings *must* sustain the pressures for which they are designed.

Readily available to users because of ample stocks at the factory, in strategically located warehouses and in the stockrooms of leading wholesale supply houses.

STOCKHAM CAST STEEL FLANGED FITTINGS AND FLANGES

Rated Working Pressures

Series Number	15	30	40	60	90	135
Steam or Hot Oil at Max. Temp. of 750° F.	150	300	400	600	900	1350
Boiler Feed Lines at Max. Temp. of 450° F.	...	325	500	720	1080	1625
Hot Oil or Vapor at Max. Temp. of 900° F.	...	275	375	550	825	....
Hot Oil or Vapor at Max. Temp. of 1000° F.	...	225	325	475	725	....
Water, Oil, Air or Gas at Max. Temp. of 100° F.	300	500	750	1000	1500	2250
Hydrostatic Test Pressure at Max. Temp. of 100° F.	500	750	1000	1500	2000	3000

All Pressures are in pounds per square inch (gage).

CAST STEEL SCREWED FITTINGS

Working Pressure Ratings

- 300 pounds Steam and any total Temperature up to 750° F.
- 225 pounds Oil or Vapor Pressure and Temperatures up to 900° F.
- 800 pounds Cold Oil, Gas or Water Working Pressure.

Tested to 800 Pounds Hydraulic Pressure—Can Be Tested to 1500 Pounds Hydrostatic When So Ordered

HEAVY CAST STEEL SCREWED FITTINGS

Working Pressure Ratings

- 600 pounds Steam and any total Temperature up to 750° F.
- 475 pounds Oil or Vapor Pressure and Temperatures up to 900° F.
- 2000 pounds Cold Oil, Gas or Water Working Pressure.

Tested to 2500 Pounds Hydraulic Pressure

HEAVY OIL MALLEABLE FITTINGS

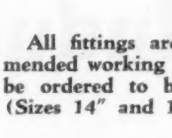
Working Pressures for Oil, Water and Gas at Normal Temperatures

1″ and smaller	2,000 lbs.
1¼″ to 2″	1,500 lbs.
2½″ to 4″	1,000 lbs.
5″ to 10″	800 lbs.
12″	600 lbs.

Working Pressures for Steam at Temperatures not to exceed 450° F.

6″ and smaller	300 lbs.
8″ and larger	250 lbs.

All fittings are hydrostatically tested to the above recommended working pressures, but if wanted, sizes above 2½″ can be ordered to be tested to 1,500 lbs. hydrostatic pressure. (Sizes 14″ and 16″ are recommended for large vapor lines.)



OIL MALLEABLE FITTINGS

Working pressures of 200 lbs. for cold water, oil and gas; steam working pressures to 175 lbs. and for lines where the temperature does not exceed 350° F.

HYDRAULIC MALLEABLE FITTINGS

Working Pressures for Cold Water or Oil

1″ and smaller	2,000 lbs.
1½″ to 2″	1,500 lbs.
2½″ to 4″	1,000 lbs.
5″ and 6″	800 lbs.

All Fittings are hydrostatically tested to the above recommended working pressures.

CAST IRON OIL PATTERN FITTINGS

800-Pound Test

For oil, gas or water working pressure of 400 lbs.

For steam working pressure of 250 lbs.

Special Catalog descriptive of these lines of fittings with dimensions, prices and pressures furnished upon request without charge.

STOCKHAM PIPE & FITTINGS CO., Birmingham, Alabama

Warehouses: BOSTON NEW YORK CHICAGO TULSA (*Steel Fittings only*) LOS ANGELES

Full lines of Stockham Fittings for gas, oil field and refinery use are sold by the following oil country supply houses:

Oklahoma and Texas — E. L. Wilson Hardware Co.; International Supply Co.; Midwest Piping & Supply Co.

California — The Republic Supply Co.; Petroleum Equipment Co.

Mention Where You Saw the Advertisement

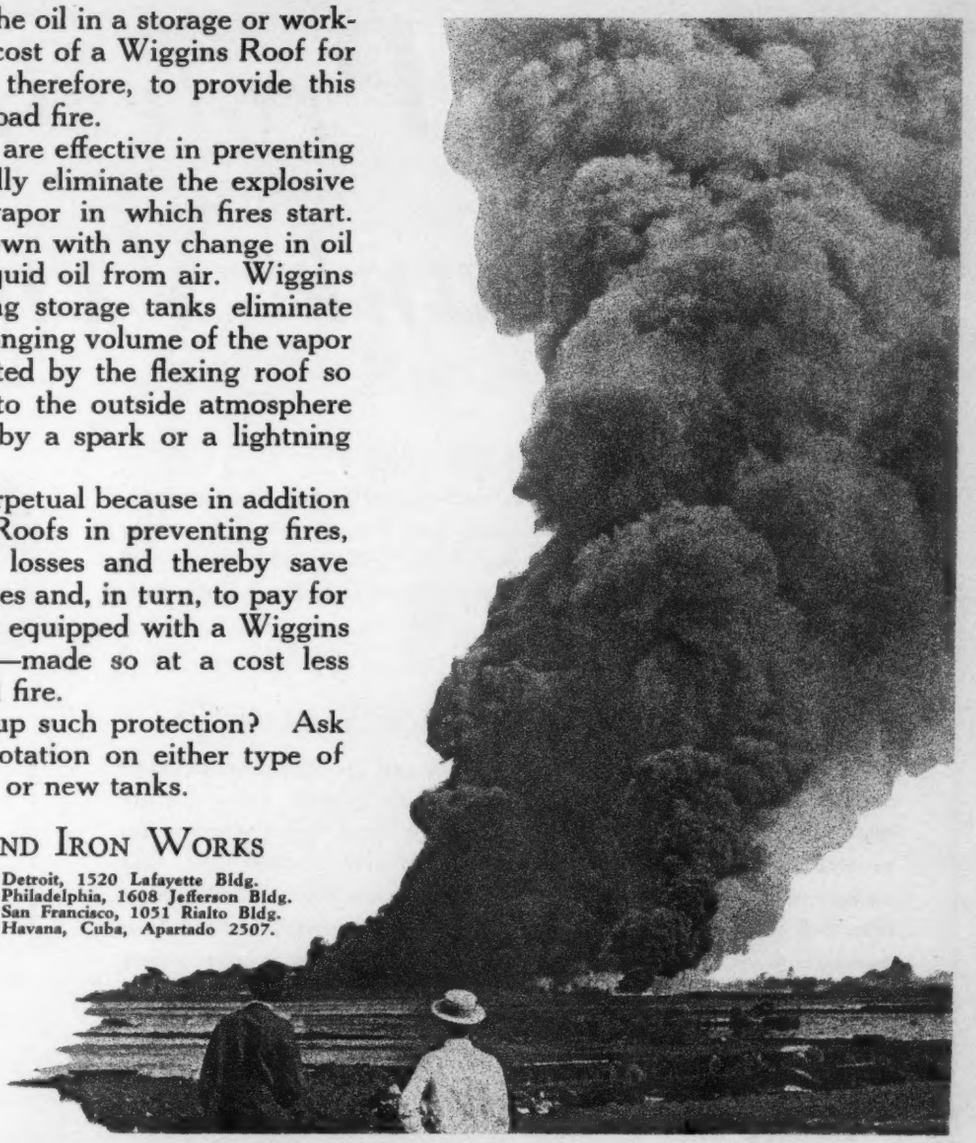
Perpetual fire protection costs less than a real fire

EVEN a partial loss of the oil in a storage or working tank exceeds the cost of a Wiggins Roof for that tank. It is cheaper, therefore, to provide this protection than to have a bad fire.

Wiggins Floating Roofs are effective in preventing fires because they practically eliminate the explosive mixtures of air and oil vapor in which fires start. These roofs ride up and down with any change in oil level, always separating liquid oil from air. Wiggins Breather Roofs on standing storage tanks eliminate thermal breathing. The changing volume of the vapor in the tank is accommodated by the flexing roof so that no vapor is released to the outside atmosphere where it could be ignited by a spark or a lightning flash.

This fire protection is perpetual because in addition to the value of Wiggins Roofs in preventing fires, they also stop evaporation losses and thereby save enough to pay for themselves and, in turn, to pay for the tanks as well. A tank equipped with a Wiggins Roof is self perpetuating—made so at a cost less than the loss from one real fire.

Can you afford to pass up such protection? Ask our nearest office for a quotation on either type of Wiggins Roofs for existing or new tanks.



Four refinery tanks were lost in the fire pictured above. At the left is shown a tank equipped with a Wiggins Floating Roof effectively protecting the oil from both fire and evaporation.

CHICAGO BRIDGE AND IRON WORKS

Dallas, 3353 Magnolia Bldg.
Chicago, 2463 Old Colony Bldg.
New York, 3102 Hudson Terminal Bldg.
Cleveland, 2234 Union Trust Bldg.
Detroit, 1520 Lafayette Bldg.
Philadelphia, 1608 Jefferson Bldg.
San Francisco, 1051 Rialto Bldg.
Havana, Cuba, Apartado 2507.

Proved by Tests

Tests conducted by oil companies prove the effectiveness of Wiggins Floating Roofs in preventing fire.

Among these tests was one in which gasoline on the roof was ignited while the roof was floating in gasoline. The contents of the tank did not ignite and no damage was done to the roof deck or trusses.

Gasoline poured around the top of the flexible seal and across the entire deck was then ignited. In four minutes the flames died down except at the seal and the gauge hatch. These continued as long as the gasoline in the tank boiled—thirteen minutes. The roof came through this test also with no damage.

FLOATING *for working storage* **WIGGINS ROOFS** BREATHER *for standing storage*

RNGM12-Gray

Mention Where You Saw the Advertisement

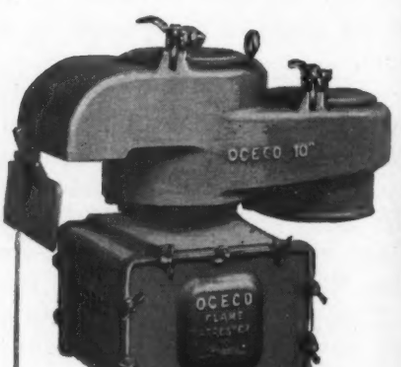
Are Screens Effective Fire Protection for Tank Vents?

Consider this:

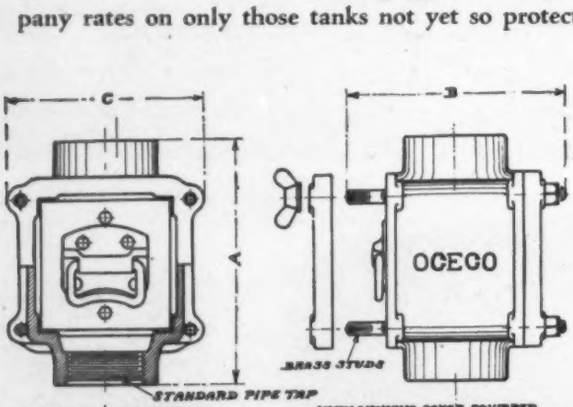
PUBLISHED reports of various tests made by the Underwriter's Laboratories show that flames easily pass through 40 mesh screens —used double and even triple—whether flat, cylindrical or conical in shape. The actual fire record of tanks with screened vents supports these findings.

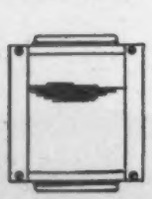
And this from the Insurance Schedules:

Schedules of the Western Acturial Bureau and the State of Oklahoma revised this year after careful study of fire records, recognize the relative hazards of screens and Laboratory listed flame arrestors for protecting vents, and favor with *lower insurance rates,* the tank owners whose tanks are equipped with Laboratory listed flame arrestors. Before these rate reductions, some oil companies carried their own insurance on their Oceco equipped tanks, paying insurance company rates on only those tanks not yet so protected.



OCECO Vent Unit Including Flame Arrestor





PLAN VIEW OF FLAME ARRESTOR BANK

ENLARGED SECTION THROUGH FLAME ARRESTOR BANK.

OCECO Flame Arrestor (2", 3" and 4" sizes) furnished in flanged type for larger sizes

Then, these additional advantages of the Oceco Flame Arrestor (Laboratory approved)—

Larger openings—20 times the area of the hole in 40 mesh screening—to avoid clogging.

100% oversize—net opening is twice the area of the same rated pipe size.

Tube banks of high purity aluminum and its alloys—highly resistant to petroleum vapors and acids.

Easily and safely inspected.

Used wherever oil is stored—protecting millions of barrels—fire has never passed through an Oceco Flame Arrestor. Ask for complete information.

In installing flame arrestor have it next to the tank. Never have equipment between flame arrestor and tank.

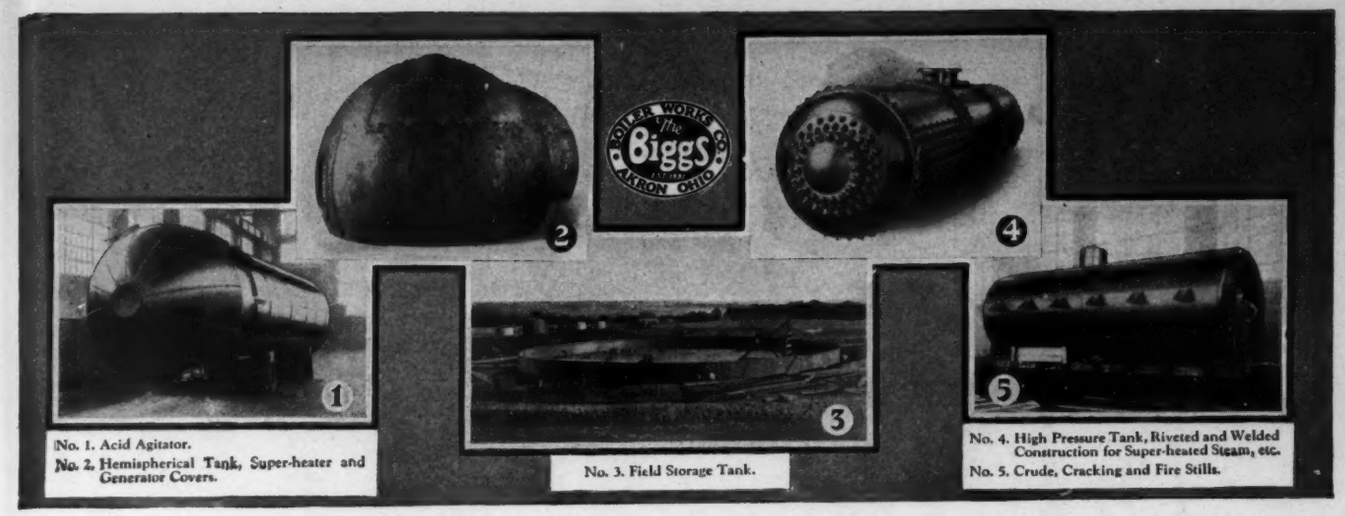
THE OIL CONSERVATION ENGINEERING CO.

877 Addison Road Cleveland, Ohio

Engineering and Sales Service:

25 Broadway, New York — Tulsa Trust Bldg., Tulsa, Okla.

Box 552, Beaumont, Texas — Neilan, Schumacher & Co., Los Angeles, Cal.



No. 1. Acid Agitator.
No. 2. Hemispherical Tank, Super-heater and Generator Covers.
No. 3. Field Storage Tank.
No. 4. High Pressure Tank, Riveted and Welded Construction for Super-heated Steam, etc.
No. 5. Crude, Cracking and Fire Stills.

Consider Biggs for Accurate Steel Plate Fabrication

Since 1887, Biggs facilities, ever widening in scope and extent, have been devoted to the accurate fabrication and prompt delivery of steel plate work of every description.

This wide experience and intimate contact with service conditions is backed by a great modern plant adequately equipped for every contingency. The equipment illustrated above, for example, indicates the broad way in which Biggs serves the chemical, oil and related industries.

Although specializing in steel plate construction to customers' specifications, Biggs carries in stock 135 standard sizes of storage and pressure tanks for immediate delivery. Riveted or welded steel pipe, penstocks, stacks and breechings are among the products which we are prepared to supply in large quantities.

If you would like to know more about the way Biggs can serve you, mail the coupon below for our interesting literature fully illustrating Biggs facilities and showing typical special jobs.

Manufacturers of

- Pressure Stills for Cracking Process
- Fractionating Towers
- Dephlegmating Towers
- Bubble Towers
- Heat Exchangers
- Agitators
- Steam Stills
- Crude Stills
- Condenser Boxes
- Run Down Tanks
- Blending Tanks
- Hemispherical Tanks
- Blow Cases
- Acid Tanks
- Compounding Kettles
- Storage Tanks to 80,000 Barrels
- Smoke Stacks and Breechings, etc.

Now is the right time to mail this coupon

THE BIGGS BOILER WORKS COMPANY

General Offices and Works: Akron, (25) Ohio
Eastern Sales Office: 300 Madison Ave., New York City
Western Sales Office: 35 S. Dearborn St., Chicago, Ill.

The Biggs BOILER WORKS CO. AKRON OHIO EST. 1887 TRADE MARK REGISTERED

TANKS AND GENERAL
STEEL PLATE WORK
for the Oil Industry

THE BIGGS BOILER WORKS COMPANY
Akron, (25) Ohio

Please send us, without obligation, a copy of "What Biggs Does, and How." We are interested in the following equipment.....

Please see us on or about.....

.....

Firm .....

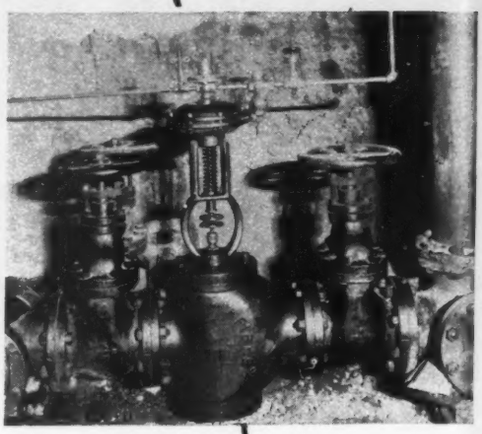
Individual .....

Address .....

Mention Where You Saw the Advertisement

Fisher Pilot Operated Boiler Gas Fuel Governor

Type No. 519



The Type No. 519 FISHER Boiler Gas Fuel Governor with self contained Pilot Control operates in the same manner as the pressure regulator and relief valves outlined previously.

Generally the gas pressure in the main leading to the gas burners is low. In order to get sensitive regulation the valve body must not restrict the flow. With these conditions in mind The Fisher Governor Company have designed a stream line valve body having extremely large valve ports. The stream line contour of the valve permits the gas to flow through the valve body without restriction. The large valve ports provide for large capacity and sensitive body without restriction.

The pilot control is set for the desired boiler pressure. As the boiler pressure builds up beyond the setting of the pilot control, the pilot valve opens and allows pressure to be applied to the diaphragm of the main governor which throttles the flow of gas to the burners. If the boiler pressure drops below the setting of the pilot valve, the pilot closes and allows pressure in the diaphragm to be bled out through the needle valve. The spring of the main valve opens the governor wide immediately and allows more gas to pass to the burners.

The FISHER Boiler Gas Fuel Governor is designed so that when the diaphragm of the main valve is in its lowest possible position, the inner valve is cracked open a small amount. This allows gas to pass through the governor at all times so that the pilot light will be burning regardless of whether the governor is open or closed. No by-pass is necessary.

If further information on any of the units is desired, please write to

THE FISHER GOVERNOR COMPANY

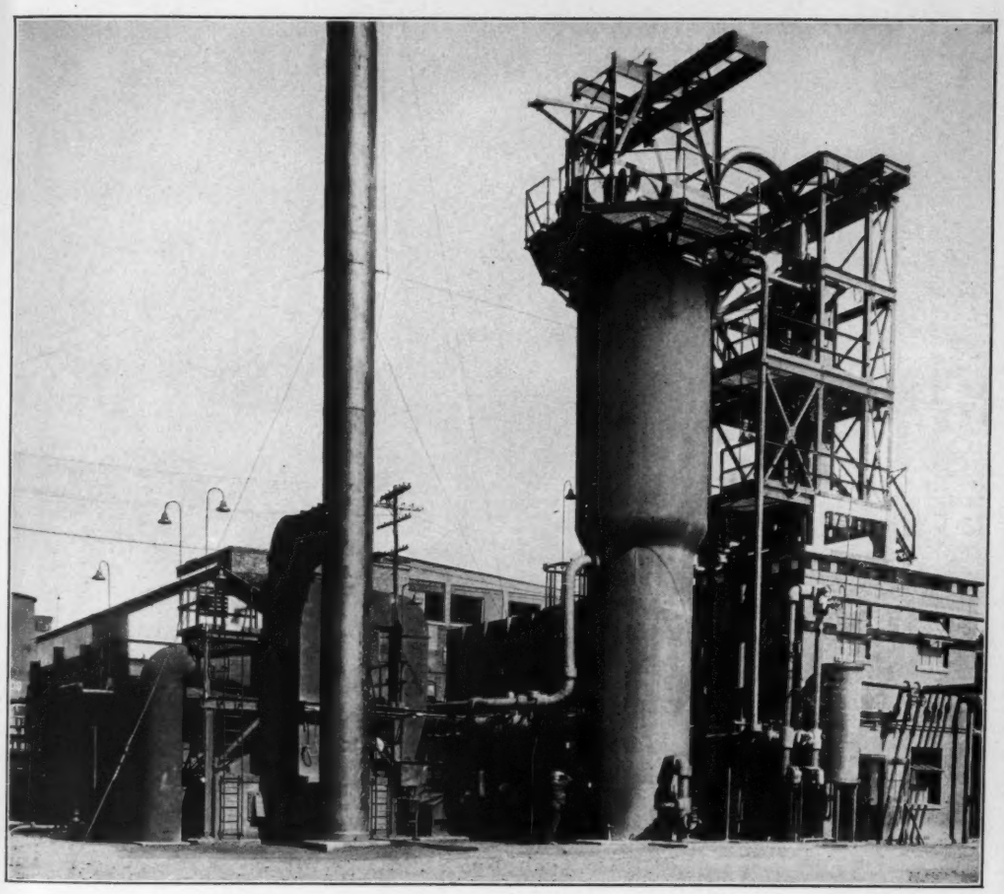
Marshalltown, Iowa

1300 Fisher Building

You could use a saving like this . . . In the mid-continent field . . . a Fisher Type 519—1½″—operating on 4 oz. pressure, produced an average fuel *saving of over* $30.00 *per month.*

Fisher has made many other like savings . . . let's talk about your job!

BADGER FACILITIES AND ORGANIZATION



The Badger Organization is complete and comprises

Research and development laboratories
Manufacturing facilities Engineering organization
Field construction organization Competent operating force

BADGER EQUIPMENT AND COMPLETE UNITS representing latest developments, are in use or in course of installation, in many of the most important refineries in the United States and foreign countries.

The following Companies are some of those who have purchased BADGER Equipment.

Magnolia Petroleum Co., of Texas
Roxana Petroleum Corp.
Craig Oil Co.
Freedom Oil Works Co.
Texas Pacific Coal & Oil Co.
Gulf Refining Co.
Skelly Oil Co.
Phillips Petroleum Co.
Pierce Petroleum Corp.
Tide Water Oil Co.
Anglo-Persian Oil Co., Ltd.
Empire Refineries, Inc.
Marland Oil Co.
Vacuum Oil Co.
Associated Oil Co.
Barnsdall Corp.
Humble Oil & Refining Co.
Tidal Refining Co.
Standard Oil Co. of N. J.
General Petroleum Corp.
Beacon Oil Company
Lubrite Refining Co.
Pennzoil Company
Shell Company of California
New Orleans Refining Co.
Emlenton Refining Co.
Independent Refining Co.
Richfield Oil Co.

E. B. BADGER & SONS COMPANY

NEW YORK • • TULSA • • LOS ANGELES • • BOSTON

Mention Where You Saw the Advertisement

FLUOR TOWERS *are* Up to date!

The old style cooling tower which sprays the whole plant vicinity whenever there is a light breeze, is a nuisance and an expense.

It is obsolete

Fluor Towers Are Modern

When the wind is blowing, Fluor Patented Drift Eliminators can be set in a few seconds.

When the wind dies down, only a few seconds are required to adjust all the eliminator panels so that they function as additional cooling decks.

This saving in water alone usually pays the slight additional cost in a few months.

Write for the Fluor catalog showing towers for every requirement.

Jackson Engineering & Equipment Co.

1022 Pacific National Bank Building
Los Angeles, California

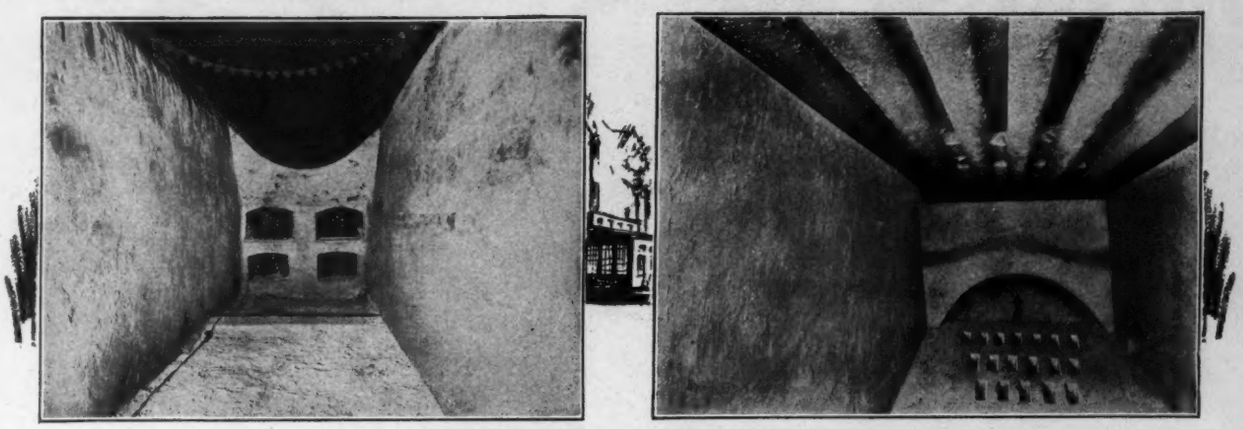
502 National Bank of Commerce Bldg., Tulsa, Okla.

2015 Magnolia Bldg., Dallas, Texas

90 West St., New York City

FLUOR REDWOOD COOLING TOWERS

A Complete One-Piece Furnace Lining



Like a Large Solid Brick

When a one-piece Quik-Pach furnace lining has matured, it is just like a large, solid, A. P. Green "Empire" fire-clay brick...Quik-Pach *is* A. P. Green fire brick in stiff, putty-like, easy-working form. It is made from exactly the same *new, unused* materials. No old materials, torn out of old burnt settings, are ever used...Quik-Pach is preburned. Shrinkage is almost entirely eliminated. It is practically neutral as to expansion and contraction—has the same resistance and reaction to heat and temperature changes as A. P. Green high-grade fire-brick.

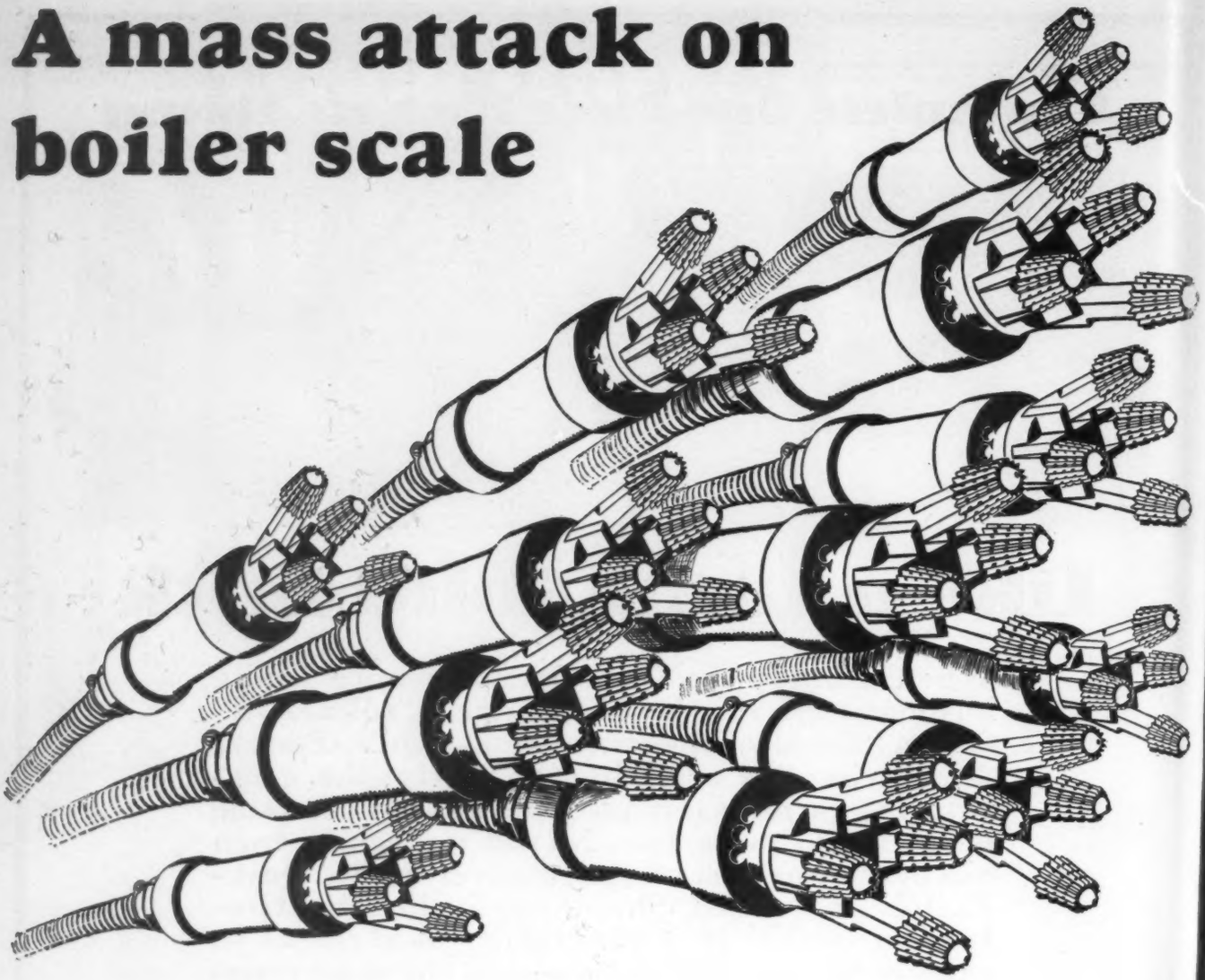
Keep Quik-Pach on hand—for building one-piece, air- and gas-tight linings, repair work, patching, building bridge walls, jambs, arches, door linings, special shapes.

Order from your nearby distributor or have it shipped direct with your A. P. Green fire brick.

Send for our new Quik-Pach Book

A.P. GREEN FIRE BRICK CO.
MEXICO, MISSOURI, U.S.A.
New York · · Chicago · · St. Louis · · London

A mass attack on boiler scale



A large Pittsburgh Steel Mill has a number of large boilers each with 1600 tubes contained in 6 drums in each boiler. As soon as a boiler comes off the line, twelve Liberty Cleaners hit the job in a body—and "time out" for the boiler is cut to the bone.

Several refineries have used the same idea, using a number of Liberty Cleaners at a time in cleaning a still, greatly cutting down the cleaning time. It's a good idea.

There are Liberty Cleaners exactly suited to the various tubes and pipes to be cleaned in your refinery. Write for the catalog.

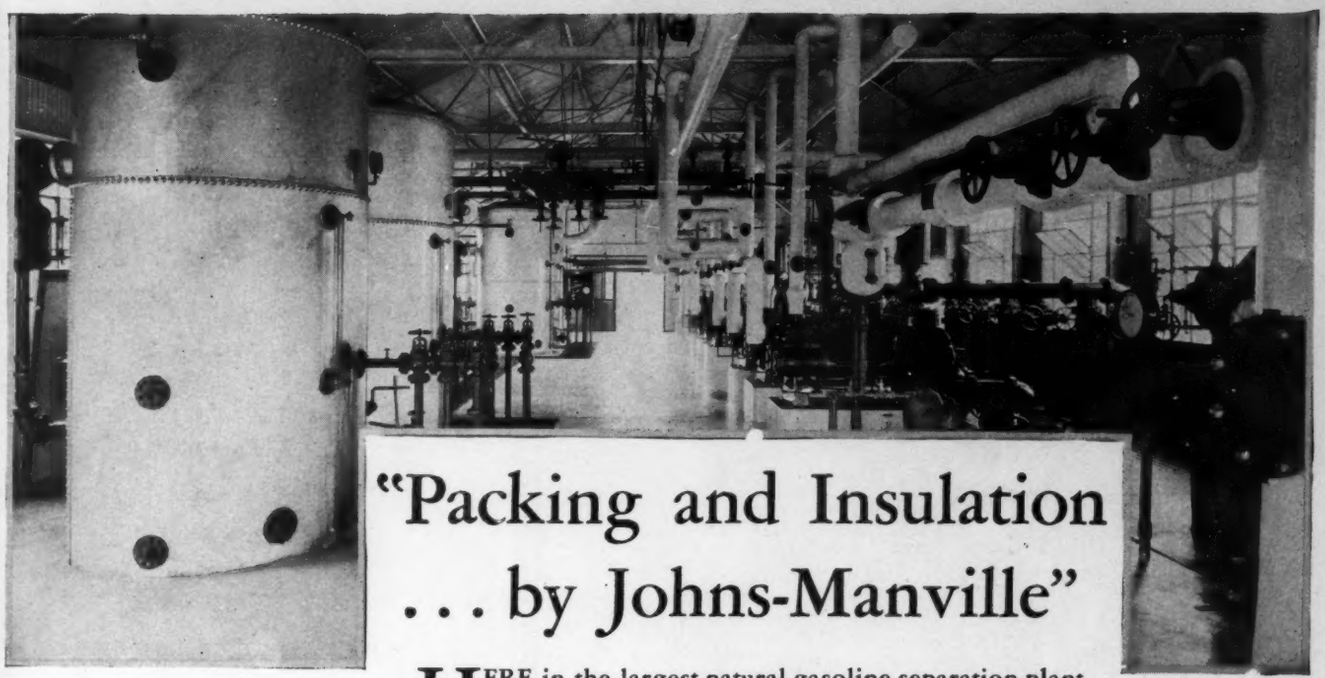
Liberty Manufacturing Co.

Jeannette, Pa.

Z-1072a

Mention Where You Saw the Advertisement

The Sinclair Plant at Seminole, Oklahoma



"Packing and Insulation . . . by Johns-Manville"

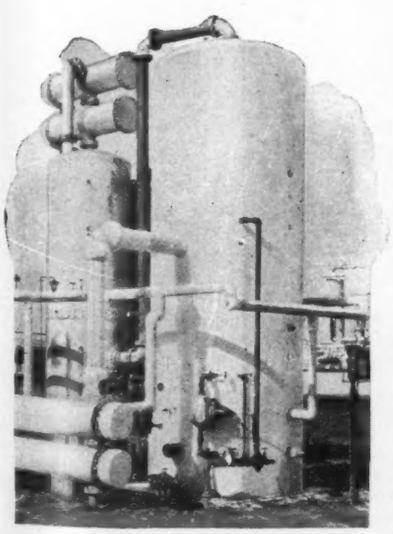
General view of control house showing Johns-Manville Insulation on steam lines.

HERE in the largest natural gasoline separation plant in the world, no effort has been spared to insure the highest efficiency and economy of operation. All feasible methods are employed to prevent leakage and avoid dissipation of heat.

As a result, every flanged connection throughout this huge plant is sealed and kept tight by Johns-Manville Service Sheet Cut Gaskets.

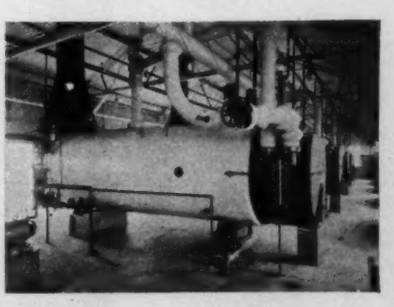
On all heat exchangers, pre-heaters, drain tanks, distillation columns, rectifying towers, reflux condensers, Casey Hedges boilers and on the piping both inside and outside the plant, Johns-Manville Insulation is saving the Sinclair Company thousands of dollars yearly by preventing costly heat loss.

General view of boiler house showing J-M Insulation on boilers and steam lines.



All heat exchangers, towers and strippers are kept at highest efficiency by J-M Insulation.

There is a Johns-Manville Insulation for every service condition. Johns-Manville Packings wherever used are unequalled for performance. Our specialized experience of more than half a century of close contact with the gas and oil industry is freely yours to draw upon. *Consult our engineers about your packing and insulation problems. Address Johns-Manville Corporation at New York, Chicago, Cleveland or San Francisco.*

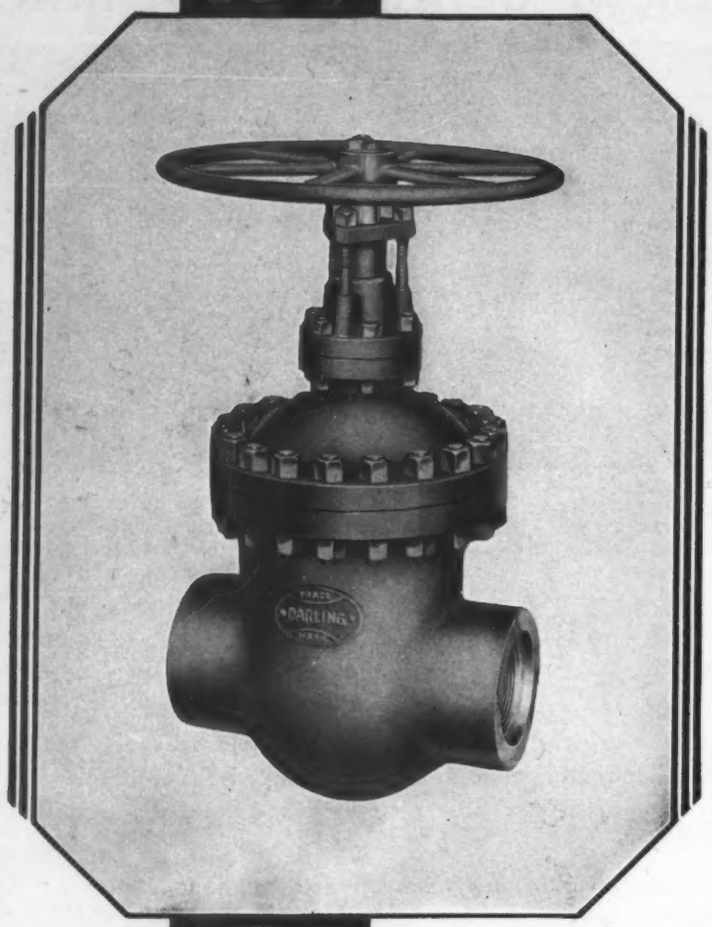


MASTER of ASBESTOS

Johns-Manville

PACKING and INSULATION

Mention Where You Saw the Advertisement



The Margin of Safety

High pressure wells demand something stronger and more reliable than the material that goes into the ordinary valve. It is no use walking on thin ice when you can have the solid protection of *forged* steel.

Darling Forged Steel Valves are made in working pressures of 1500 and 3000 pounds and that means, of course, a wide margin of safety for your men and property.

Descriptive catalog on request. Send for it.

DARLING VALVE & MANUFACTURING CO.

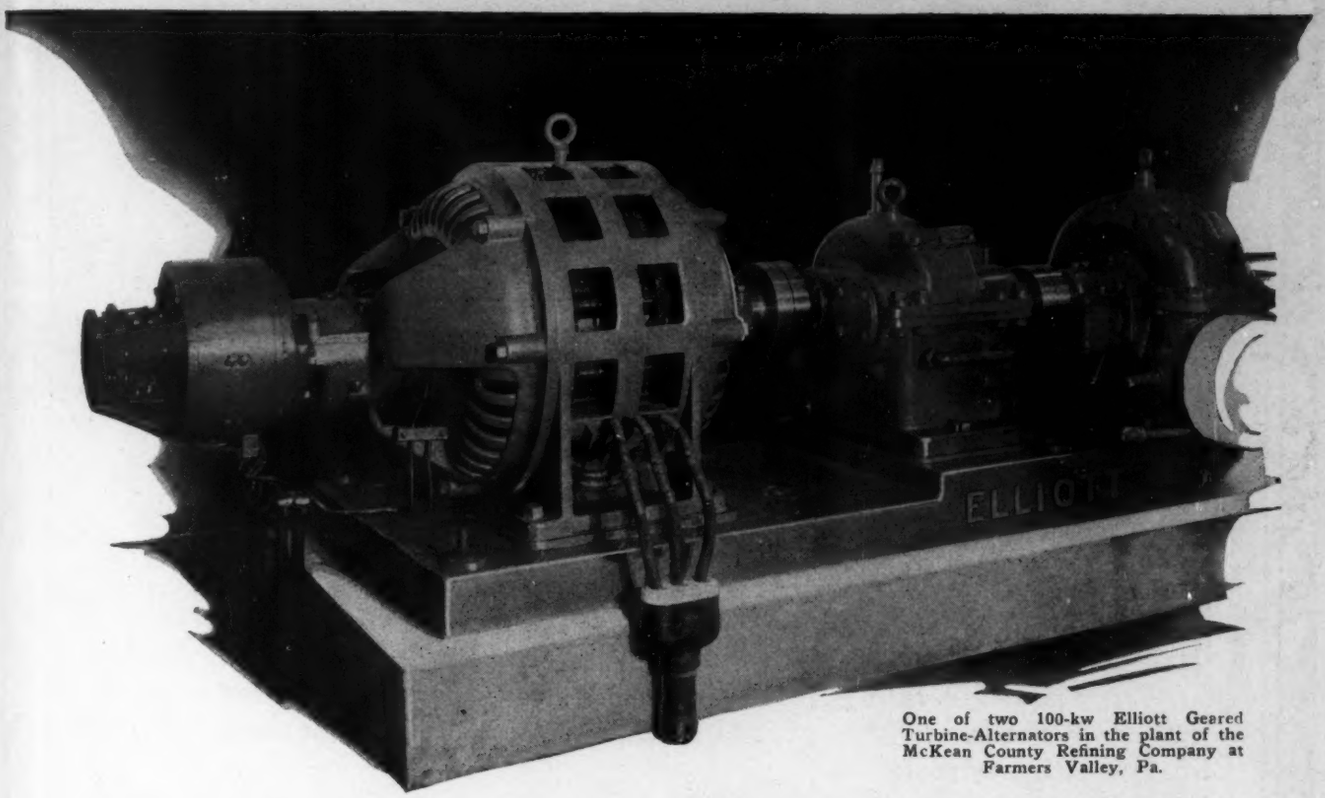
Williamsport, Pa.

NEW YORK CHICAGO OKLAHOMA CITY HOUSTON

DARLING

GATE VALVES

ELLIOTT for Turbine-Generators



One of two 100-kw Elliott Geared Turbine-Alternators in the plant of the McKean County Refining Company at Farmers Valley, Pa.

Dependable, economical power —and steam for distillation

The McKean County Refinery at Farmers Valley, Pa., is isolated from outside electric power sources and dependent upon its own plant for generating electric current. Two 100-kw. Elliott Turbine-Generator Sets give them power at very low cost, and service "as good or better than could be had from outside sources," they say.

The economy of the plant is very high as they are able to operate their turbines as reducing valves, taking steam from the boilers at 125 pounds pressure and operating the turbines against a back pressure of 25 pounds, utilizing the 25-pound steam for distillation purposes. The power load on the turbine is balanced nicely against the exhaust steam requirements.

The power is used for lighting the plant, operating continuous circulating pumps in the refrigeration plant, operating centrifuges and various conveyor equipment.

Many refineries are in position thus to skim very cheap power from process steam. If your power requirements overbalance the process steam needs, a bleeder type turbine might serve better than a straight non-condensing unit.

Let our engineers go into the proposition with you.

ELLIOTT COMPANY
PITTSBURGH, PA.
General Sales Offices **JEANNETTE, PA.**
District Offices in principal cities

Elliott Power Equipment includes engines and turbines, generators and electrical machinery, condensers, deaerators, centrifugal blowers and accessory equipment.

H-523

THE ELECTRONIC TORNADO

A process of automatic arc welding which represents a distinct advance in the welding art

THE Electronic Tornado Process of automatic carbon arc welding is now available for manufacturers of tanks, boilers, steel pipe and any products where steel is to be joined to steel on a production basis.

Welds made by this process develop greater strength and are more ductile than welds made by any other commercial process. Welding speeds are greater than by other welding methods, and this process is adaptable for either light sheet or heavy plate.

Since welding speeds are high the cost per foot of weld is low. On ½" plate the rate of welding is 25 feet per hour and the cost is lower than by any other known method.

The crystalline structure of welds made by the Electronic Tornado Process is remarkably fine and uniform and the metal in the weld is actually superior to the parent metal.

Microphotographs of sections through the fusion zone show a gradual transition from the crystalline structure of the parent metal to that of the weld metal. In no place is the metal weakened by the welding process.

Space does not permit a description of the process itself. However, a descriptive bulletin covering the Electronic Tornado is available and will be sent on request.

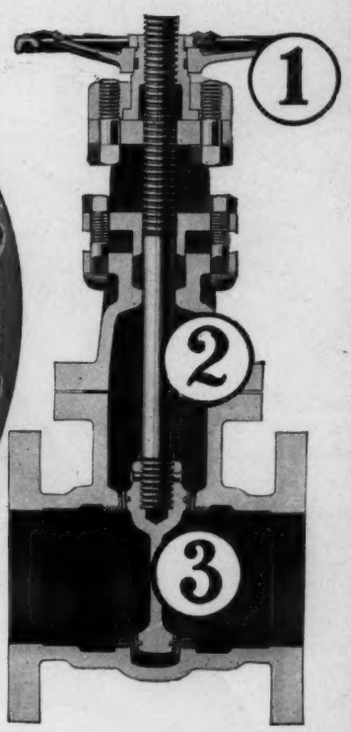
J. F. Lincoln

Vice President and General Manager

THE LINCOLN ELECTRIC COMPANY

CLEVELAND, OHIO

PRATT & CADY
STANDARD IRON BODY GATE VALVES



Constantly improved
—to meet most exacting conditions

At the right are listed several recent improvements in Pratt & Cady Standard Iron Body Gate Valves. These are evidences of the constant refinements that make Pratt & Cady Valves the most serviceable and economical to the user. The Standard Iron Body Gates have long been made of high test cast iron—a stronger, closer grained metal than standard specifications require. This gives much better seating surfaces in all iron valves. In both bronze trimmed and all iron valves the wedge guides reduce the wear on the seats.

These are a few of many other reasons for specifying Pratt & Cady. Let us help you with your valve problems. Write or wire.

1 Certified malleable iron hand wheels are now standard on Pratt & Cady Iron Body Valves.

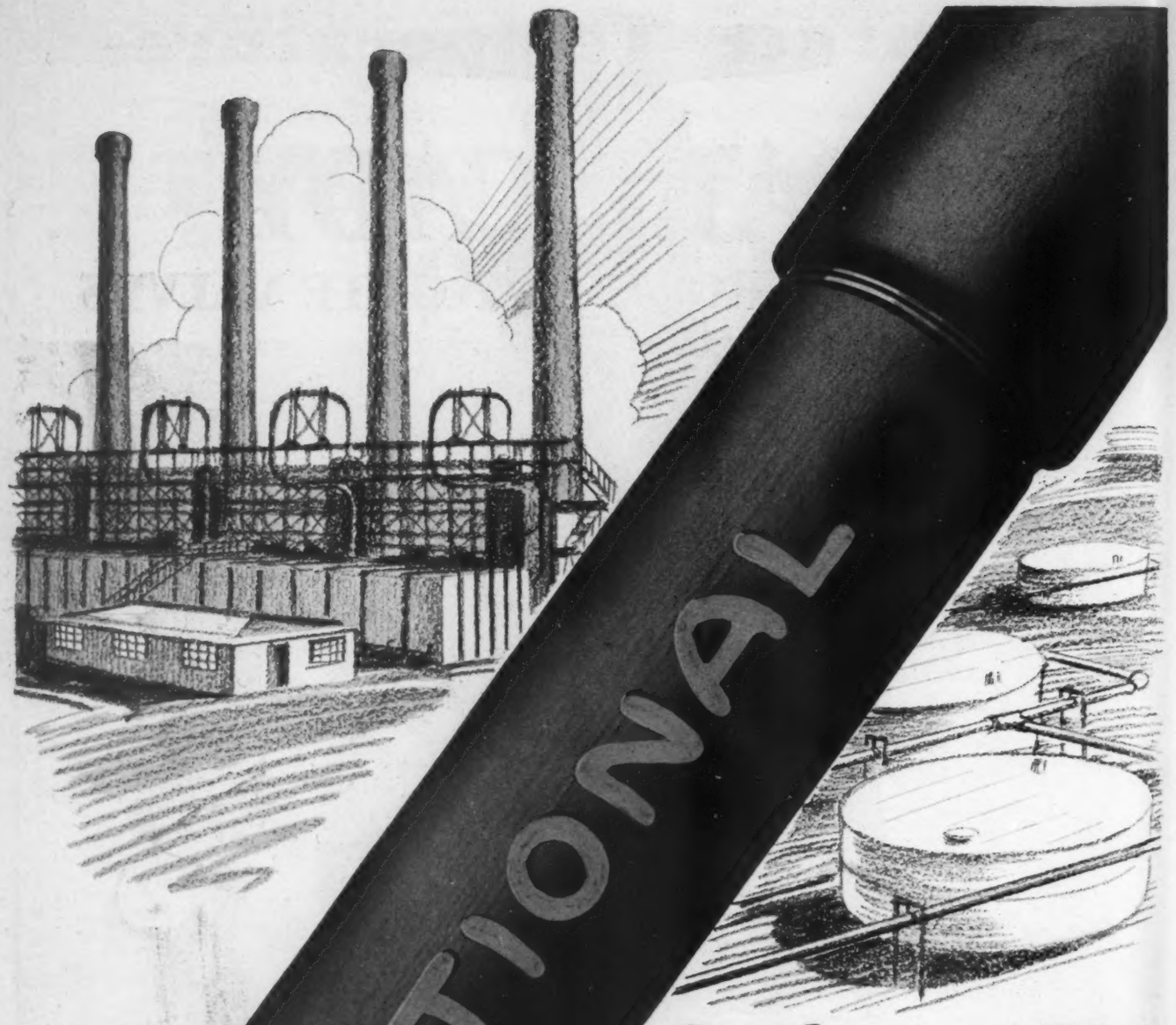
2 Bronze spindles are now made of 75,000 lb. rod stock, except larger sized non-rising spindles which are 55,000 lb. manganese bronze. Steel spindles are heat treated to make them rust-proof.

3 I-Beam type wedges are now standard in all sizes.

READING STEEL CASTING COMPANY, Inc.
An Associate Company of the American Chain Company, Inc.
BRIDGEPORT, CONNECTICUT
Offices and Warehouses in Principal Cities

READING *for steel*
PRATT & CADY *for iron and bronze*
specializing for quality valves and fittings
"There can be no compromise with safety"

Stocked by Reading Steel Casting Co., at Tulsa, Houston and San Francisco
Grinnell Company of the Pacific, Los Angeles



Settle your Pipe Problems now!

For ordinary replacements, extension of present equipment, or building an entirely new unit—refinery engineers can settle once for all time the question of the right pipe to use. No matter how varied the pipe requirements in the plant, there is a "NATIONAL" Pipe for the purpose. And you take no chance with quality when you use this material because the same quality is built into every type of "NATIONAL" Pipe, regardless of its size or purpose. Over half a century of manufacturing experience behind the product, backed by the judgment of America's leading refinery builders, justify your confidence in standardizing on one pipe for all refinery purposes. Available in all sizes, for any pressures, for any type of joint and for all kinds of bending and forming operations.

NATIONAL TUBE COMPANY, Pittsburgh, Pa.

NATIONAL PIPE

Mention Where You Saw the Advertisement

Accurate Temperatures

For Correct Volume Calculations

Automatic Temperature Control

Operator taking temperatures accurately through hatch in top of tank. It only requires a few seconds to determine temperatures of gasoline in storage at various depths.

You should have all the facts in Bulletin 870-R. Write for a copy today.

IN all calculations of volume, temperature is a prime consideration. Shrinkage or expansion must be adjusted to 60 degrees, the standard for sales and transfers. The temperatures of crude oils, distillates, gasolines and other products in storage must be known, accurately and quickly.

An error of 100 barrels in a 50,000-gallon tank may result from a temperature miscalculation of only 15 degrees.

For taking tank temperatures the L & N Portable Potentiometer Indicator is *different.* Extremely accurate, small enough to be hung over the shoulder or carried in the hand, it gives a reading in about half a minute from the time gauge hatch is opened. The operator simply drops the thermocouple to the desired depth and takes the reading.

In casinghead storage, permanent thermocouples can be installed and the instrument used with them. Automatic recording at a central point can be made by the use of an L & N Multiple Point Recorder.

Write for the full details.

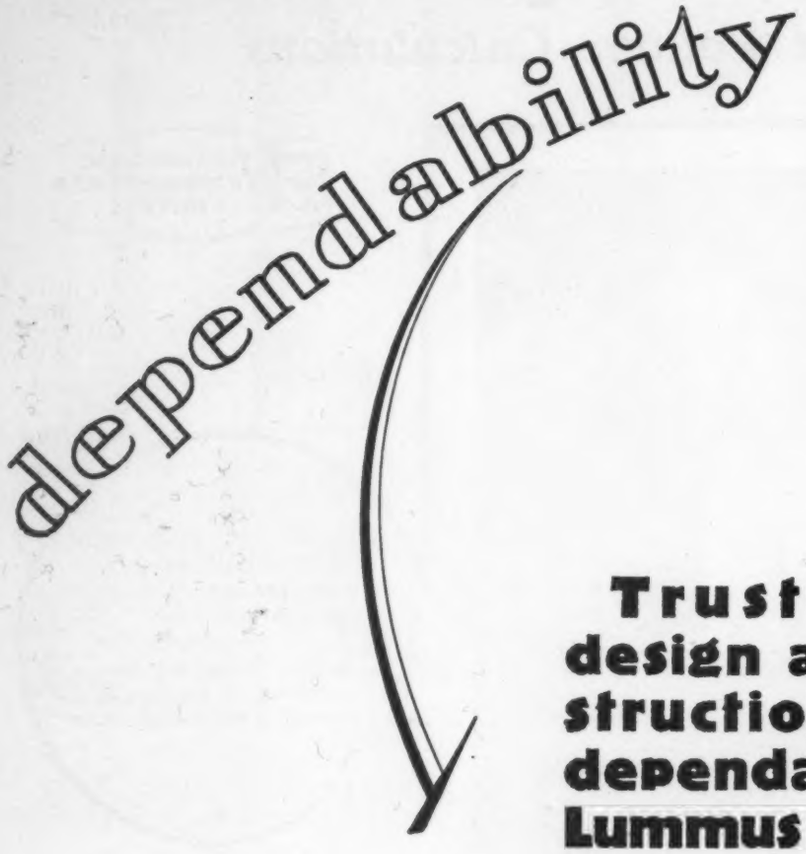
LEEDS & NORTHRUP COMPANY
ELECTRICAL MEASURING INSTRUMENTS
PHILADELPHIA, PA.
Branch Offices: Cleveland Chicago Houston Los Angeles San Francisco

The "*Different from all others*"

Potentiometer

most accurate • • PYROMETER • • in industry

P-79



Trustworthy design and construction insure dependability in Lummus Refining Plants. Low operating costs, maximum yields, sustained operating, ease of control, and high quality of products, are also characteristic of the Lummus system of Low Temperature Refining

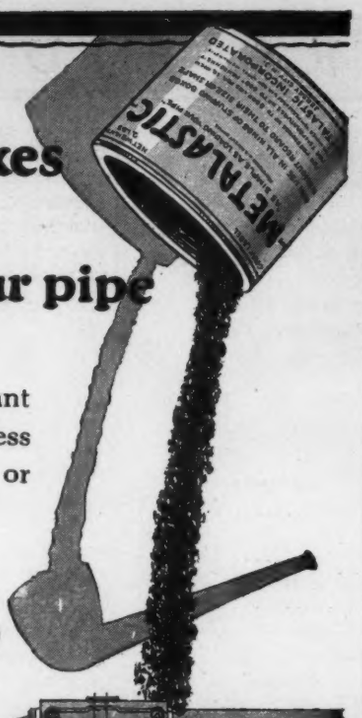
The

Walter E. Lummus Co.

148 State Street Boston, Mass.

New York Office, 30 Church Street

Packing Stuffing Boxes as easy as loading your pipe



Serves in any plant equipment, regardless of service, pressure or temperature.

METALASTIC INCORPORATED
Jersey City, N. J.

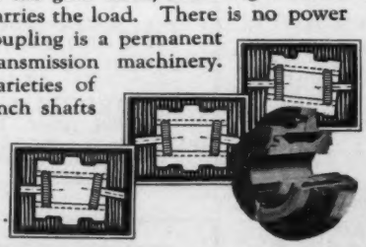
METALASTIC
For *All* Stuffing Box Requirements!

Replacements Banished by FAST'S COUPLING

SHUT-DOWNS for replacing pins, bushings, springs, discs or grids in flexible couplings are a thing of the past—when you standardize on the coupling that has no flexible members.

Instead, in Fast's flexible coupling, two spur gears, one on each shaft end, are completely and continuously meshed in oil with the internal gears of a floating sleeve. The shafts and sleeve turn noiselessly as one unit, allowing free angular and lateral movement.

Oil between the gear teeth, under high centrifugal pressure, carries the load. There is no power loss and the coupling is a permanent part of the transmission machinery. Built for all varieties of service from 1-inch shafts on pumps and fans, up to huge steel mill reversing drives.



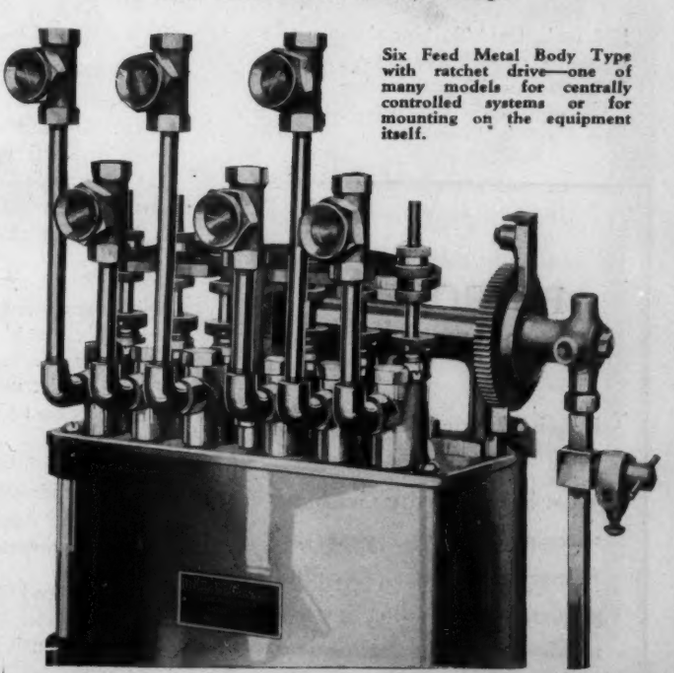
THE BARTLETT HAYWARD CO.
200 Scott Street · BALTIMORE, MD.
Write today for free BOOK

Regular and Positive

Hills-McCanna Force Feed Lubricators can be depended upon to deliver oil with the regularity of a swinging pendulum—to any distant point of friction, and in any *quantity*. This is the best method of preventing the dangers of breakdowns of production systems due to insufficient lubrication.

Hills-McCanna Force Feed Lubricators give a visible proof of the delivery of oil. "Blinkers" placed upon the pipe lines register the passage of oil and thus give assurance of its final delivery at the point of friction. The single plunger principle—the packed stuffing boxes—ball valves—are the basis of the successful Hills-McCanna design. There are types from 1 to 60 feeds to serve all lubricating conditions.

HILLS-McCANNA CO.
2349 NELSON STREET, *Chicago*



Six Feed Metal Body Type with ratchet drive—one of many models for centrally controlled systems or for mounting on the equipment itself.

HILLS-McCANNA
FORCE FEED
Lubricators

ADVERTISERS INDEX

American Cast Iron Pipe Co. ... 4
Andrews-Bradshaw Company ..121
Arrowhead Iron Works 139

Babcock & Wilcox Tube Co. 24
E. B. Badger & Sons Company 39
Banner Rock Products Company .....Third Cover
Bartlett Hayward Company 145
Bessemer Gas Engine Company...113
Biggs Boiler Works Company ... 37
Blaw-Knox Company 121
Botfield Refractories Company.. 14
C. F. Braun & Co. ....Second Cover
Briggs & Turivas 146
Bristol Company 123
The Brown Instrument Company 51
Byron Jackson Pump Manufacturing Company 6

Campbell Engineering Company.. 28
Chaplin-Fulton Manufacturing Company 134
Chicago Bridge & Iron Works ... 35
Clark Brothers Company 5
Cook Paint & Varnish Company..117
Cooke Seal Ring Company 142
Cooling Tower Company 118
C. & G. Cooper Company 56
Crandall Packing Company 143

Darling Valve & Manufacturing Company 44
DeLaval Steam Turbine Company 140
Detroit Graphite Company 18
J. P. Devine Manufacturing Company 100-101
The Duriron Company 120

Edward Valve & Manufacturing Company 143
Elliott Company 45
Engineering Research Equipment Company 126
Fisher Governor Company 38
Fluor Construction Company 40
Foster-Wheeler Corporation 10
The Foxboro Company 8

Goetze Gasket & Packing Co. ...139
Gray Processes Corporation 84
Graver Corporation 127
A. P. Green Fire Brick Company 41
Griscom-Russell Company 30

Hammond Iron Works 11
Harrisburg Pipe & Pipe Bending Company 144
A. L. Henderer's Sons Company .124
Hill, Hubbell & Company 7
Hills-McCanna Co. .....128 and 145
Homestead Valve Company 15
B. Mifflin Hood Company 120
Hope Engineering & Supply Co...131

International Compositions Co. ..132
Interstate Color Company 116

Jackson Engineering & Equipment Company 40
Johns-Manville Corporation 43

M. W. Kellogg Company 26
Kerlow Steel Flooring Company..128

Laclede-Christy Clay Products Company 17
Liberty Manufacturing Company. 42
Leeds & Northrup Company 49
B. P. Lientz & Company 12
Lincoln Electric Company 46
Walter E. Lummus Company ... 50

Mason Regulator Company 32
Maintenance Engineering Corp...138
A. Y. McDonald Manufacturing Company .....Fourth Cover
Merco Nordstrum Valve Co..... 13
Metallo Gasket Company 136
Metalistic, Inc. 145
Metric Metal Works 52
Midwest Piping & Supply Co. ... 22
Mine Safety Appliance Company.132
Mixing Equipment Company 135

National Airoil Burner Company. 33
National Meter Company 137
National Transit Pump & Machine Company 83
National Tube Company 48
Neilan, Schumacher & Company.. 3
New Jersey Asbestos Company...130
North American Car Corporation 20

Oakite Products, Incorporated ..129
Ohio Steel Foundry Company... 25
Oil Conservation Engineering Co. 36

Parker Appliance Company 118
Petroleum Iron Works Company 29
Pittsburgh Pipe Coil & Bending Company 130
Pittsburgh Steel Products Co. ... 19
Power Piping Company 136
Pulmosan Safety Equipment Corporation 134

Quigley Furnace Specialties Company 135

Reading Iron Company 115
Reading Steel Castings Company. 47
Refinery Supply Company 124
Roto Company 137

Sarco Company 128
Schutte & Koerting Company ... 27
Smith Engineering Company 31
Smith Separator Company 23
A. O. Smith Corporation 81
Stockham Pipe & Fitting Co. ... 34
Struthers-Wells Company 21
Southwestern Engineering Corp. 9

Taylor Instrument Company 140
Texas Firebrick Manufacturers Association 116
Tulsa Boiler & Machinery Co.... .....Front Cover

Union Manufacturing Company.144
Universal Oil Products Co. 97

Henry Vogt Machine Company.. 54

Warwick Hotel 138
Westinghouse Electric & Manufacturing Company 119
C. H. Wheeler Manufacturing Company 144
Williams, Brown & Earle, Inc. ..146
Winkler & Koch Engineering Co..125
Wyatt Metal & Boiler Works.... 16

PETROLEUM CHEMIST

Required for experimental work in Chicago district. Must be University Graduate with at least two years oil refinery experience. Give full particulars, including age, education, experience, present salary and minimum salary desired and send small photograph, if possible. Address, Box 1344 c/o Refiner and Natural Gasoline Manufacturer, Houston, Texas.

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

RECLAIMED ARA PROOF-TESTED TANK AND FREIGHT CAR PARTS
TANK CARS BOUGHT, SOLD AND LEASED
BRIGGS & TURIVAS
Blue Island, (Chicago), Ill.
PLANTS: Blue Island and Chicago Heights, Illinois, and Pittsburgh, Pa.

WANTED—PATENT LAWYER OR TECHNOLOGIST
Want services of patent lawyer or technologist to study oil cracking processes with particular reference to patent claims. Some previous knowledge of oil cracking patents required. Box 2221, c-o Refiner and Natural Gasoline Manufacturer.

A Banroc Engineer Can Show You How to Cut Your Fuel Bills

LET a BANROC Engineer make a survey of the conditions in your plant. He will show you where your heat leaks are, and how to permanently, efficiently and economically stop them. Whether your trouble lies in your steam lines, boilers, breechings, ovens, or wherever you use heat, there is a BANROC Product made especially for it. Ask the BANROC Engineer to make you an estimate of the cost of insulating with BANROC and the heat it will save. No obligation.

Banroc Engineers are listed in the Phone Directories of the following cities:

BOSTON NEW YORK BUFFALO NEWARK DENVER PHILADELPHIA
PITTSBURGH CLEVELAND TOLEDO DETROIT LOS ANGELES
CHICAGO ST. LOUIS HOUSTON TULSA SAN FRANCISCO

Mr. B.T.U. Says:—

BANROC INSULATION has a conductivity rating given by the U. S. Bureau of Standards that makes it a leader in *Economical Efficiency.* It is this efficiency, plus permanence and economy that makes BANROC Products an outstanding value on the market.

BANNER ROCK PRODUCTS COMPANY, ALEXANDRIA, INDIANA

BANROC INSULATION

ORIGINATORS - OF - ROCK - WOOL - PRODUCTS

A double purpose valve

Cross Section showing by-pass arrangement. Can be set at any desired pressure.

Pat. Pend.

RELIEVES EXPANSION PRESSURE IN PIPE LINES · · · ELIMINATING OVERHEAD EXPANSION LINES.

· · · · · · · PERFORMS ALL OTHER FUNCTIONS FOR WHICH STURDY McDONALD VALVES ARE USED.

EXCESSIVE pressures are generated in hot weather by the expansion of oil or gasoline remaining in line. The result—leaks at the joints and gaskets.

By incorporating a special by-pass arrangement, this new McDonald Expansion Relief Gate Valve stops all such leaks. As the pressure increases, the by-pass of the valve opens, permitting the pressure in the line to immediately equalize itself with that in tank.

No unsightly overhead expansion lines or other such arrangements are necessary. This valve gives absolute, automatic protection against all irregular pressures.

In addition, this double purpose Relief Valve has the same sturdy construction and all the other advantages of McDonald Gate Valves, known and used throughout the world.

EST. 1856 McDonald

"The Home of the Swing Joint"

A. Y. McDONALD MFG. CO.

DUBUQUE, IOWA

Omaha Minneapolis Des Moines Kansas City

There's a McDonald Distributor Near You.

McDONALD